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NCEL
Contract Report

May 1990

An Investigation Conducted by:
EcoStat, Inc.
Thousand Oaks, CA 91362

LIFE CYCLE COSTS OF NON-PCB DISTRIBUTION TRANSFORMER ALTERNATIVES

ABSTRACT The U.S. Navy is investigating transformer alternatives to replace PCB transformers. Currently, NCEL is making a technical evaluation of various non-PCB transformer replacement alternatives and determining the "Life Cycle Costs" (LCC) of these transformers. These include mineral oil, silicon oil, RTemp, amorphous core, vapor-cooled, ventilated dry, sealed dry, and cast coil, at kVA ratings of 25, 75, 150, 300, 500, 750, 1000, and 1500.

Life cycle savings of amorphous core transformers over conventional silicon steel are also analyzed and show substantial savings. A 1500 kVA amorphous core transformer that is loaded at 90 percent and with a 15 percent price differential over a similar silicon steel transformer can produce life cycle savings of nearly $75,000 with a payback of 2 to 3 years.

For the purpose of transformer cost comparison, life cycle costs are composed of the purchase price, load, and no-load costs. Life cycle costs are computed for the entire life cycle of 30 years. Energy costs of 0.06/kWh is used throughout this report with a compound growth rate of 5 percent over the assumed life cycle of 30 years for each transformer.

NAVAL CIVIL ENGINEERING LABORATORY PORT HUENEME CALIFORNIA 93043

METRIC CONVERSION FACTORS

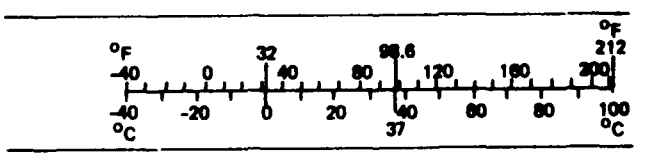
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	*kilometers*	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). *For other exact conversions and more detailed tables, see NBS* Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	*liters*	2.1	*pints*	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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13. ABSTRACT *(Maximum 200 words)*

The U.S. Navy is investigating transformer alternatives to replace PCB transformers. Currently, NCEL is making a technical evaluation of various non PCB transformer replacement alternatives and determining the "Life Cycle Costs" (LCC) of these transformers. These include mineral oil, silicon oil, RTemp, amorphous core, vapor-cooled, ventilated dry, sealed dry, and cast coil at kVA ratings of 25, 75, 150, 300, 500, 750, 1000, and 1500.

Life cycle savings of amorphous core transformers over conventional silicon steel are also analyzed and show substantial savings. A 1500 kVA amorphous core transformer that is loaded at 90 percent and with a 15 percent price differential over a similar silicon steel transformer can produce life cycle savings of nearly $75,000 with a payback of 2 to 3 years.

For the purpose of transformer cost comparison, life cycle costs are composed of the purchase price, load, and no-load costs. Life cycle costs are computed for the entire life cycle of 30 years. Energy costs of 0.06/kWh is used throughout this report with a compound growth rate of 5 percent over the assumed life cycle of 30 years for each transformer.

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EXHIBITS

EXECUTIVE SUMMARY

A life cycle costs analysis of non-PCB distribution transformers was performed. Eight (8) transformer alternatives at eight (8) different kVA ratings were evaluated.

The eight transformer replacement alternatives considered are:

- Mineral Oil
- Silicone Oil
- RTEmp
- Amorphous Core
- Vapor-cooled
- Ventilated Dry
- Sealed Dry
- Cast Coil

The eight kVA ratings are: 25, 75, 150, 300, 500, 750, 1000, 1500. Except for 25 kVA-rated transformers, which are single-phase, the rest are three-phase.

For the purpose of transformer costs comparison, life cycle costs were composed of the purchase price and load and no-load costs. Life cycle costs were computed for the entire life cycle of 30 years. Present values, using a nominal discount rate of 10%, were also computed. Purchase prices of transformers were based on "quantity discounts" of 10 transformers purchased at the same time.

Energy cost of $0.06/kwh is used throughout this report, with a compound growth rate (based only on inflation and excluding any changes in real supply-demand) of 5% per year over the assumed life cycle of 30 years for each transformer. A constant inflation rate of 5% is assumed.

The cost of $0.06/kwh is the average energy cost charged by the Public Utility Companies (PUCs) for electric power at Public Works Centers (PWCs) such as at Norfolk-Virginia, Pearl Harbor-Hawaii, and San Diego-California. Virginia Electric Power charges the PWC-Norfolk between $0.045/kwh and $0.050/kwh. Hawaiian Electric Power charges the PWC-Pearl Harbor $0.065/kwh and San Diego Gas and Electric charges the PWC-San Diego $0.072/kwh. These electric energy rates are based on information provided by officials at the various PWCs.

A load rating of 50% of nameplate rating was assumed as a representative average for the Norfolk Navy base. However, load ratings as low as 10% and as high as 90% have been observed.

Liquid-filled transformers, such as mineral oil, silicone, RTEmp, and amorphous core, generally demonstrate lower life cycle costs. This is to be expected, since typically liquid-filled transformers have lower load losses than dry-type transformers, such as cast coil. Since both load and no-load costs are heavily dependent on energy costs ($/kwh), liquid-filled transformers will be cost competitive in a high cost energy environment.

Liquid-filled transformers, such as mineral oil, silicone, and RTEmp, generally have the same load and no-load losses. However, they can differ substantially in purchase price due to the difference in the costs of liquids, such as mineral oil and silicone. Amorphous core transformers have lower no-load losses, and contain either mineral oil or silicone.

Life cycle savings of amorphous core transformers over conventional silicon steel were also analyzed. These savings can be substantial. For example, at 90% load rating with a 15% price differential of amorphous core over silicon steel, a 1500 kVA amorphous core transformer can produce life cycle savings of nearly $75,000, with a payback in 2-3 years. Payback is the time required to offset the extra cost of an amorphous core transformer by the accrued, expected savings in energy costs.

Amorphous core transformers can be purchased at a 30% price differential over silicon steel transformers when based on quantity discounts. By the mid-1990s the projected prices of amorphous core transformers will drop to a 15% price differential, due to further advanced technology, productivity improvements in manufacturing processes and economies-of-scale.

Installation and transportation costs depend heavily on site-specifics and environmental constraints, and are ignored in this analysis. For a "normal" site, a cost of $200 for installation and transportation can be expected and added to the life cycle costs. Costs for liquid-filled transformers can be higher, due to the special handling needs and environmental compliance. Dry-type transformers have generally less installation costs.

Maintenance costs for distribution transformers are negligible, and are ignored. Costs, if any, are less for dry-type transformers, which require annual dusting and cleaning, than for liquid-filled transformers. Liquid-filled transformers require a periodic check of the temperature and level of the insulating oil.

Dry-type transformers, such as cast coil, can be very cost-effective, given that these transformers can be switched on-and-off easily, thereby reducing overall no-load costs when not in use. The cost reduction, which can be significant, depends on the load duty cycle. They can also be used indoors or outdoors without much restriction.

TRANSFORMER REPLACEMENT ALTERNATIVES

1.1 Introduction

This is an analysis of transformer replacement alternatives based on the life-cycle costs (LCC) of non-PCB transformers. The Navy's Public Works Center (PWC) at Norfolk is evaluating non-PCB transformers which can be used to replace PCB transformers. To assist the PWC in their evaluation, the Naval Civil Engineering Laboratory (NCEL) is conducting technical and economic analyses.

There have been nearly 240 PCB transformers identified so far at the Naval Base in Norfolk, and these PCB transformers will have to be replaced (or retro-filled) in order to meet environmental regulations and minimum standards set forth by the Environmental Protection Agency (EPA).

The PCB transformer explosions at Norfolk and Pearl Harbor have caused work stoppages and resulted in decontamination costs estimated at $12 and $3 million respectively. Final costs for these incidents at the two Navy bases could well exceed $55 million, not including potential lawsuits. And recently, a similar accident in Guam involving a PCB transformer has been reported.

Thus, in addition to life cycle costs, replacement of PCB transformers will also include factors relating to safety, efficiency, reliability, and Navy mission requirements.

1.2 Non-PCB Transformer Alternatives

Eight non-PCB transformer alternatives at 8 different kVA ratings are evaluated. The 8 transformer replacement alternatives are:

- Mineral Oil
- Silicone Oil
- RTEmp
- Amorphous Core
- Vapor-cooled
- Ventilated Dry
- Sealed Dry
- Cast Coil

The 8 kVA ratings are: 25, 75, 150, 300, 500, 750, 1000, 1500. Except for 25 kVA transformers which are single-phase, the rest are three-phase transformers.

TECHNICAL COMPARISONS OF TRANSFORMER ALTERNATIVES

2.1 Liquid-filled Transformer Alternatives

The four liquid-filled transformer alternatives evaluated in this study are: **Mineral oil, Silicone, RTEmp, and Amorphous Core.**

Typical transformer liquids which are in use, and have been used, are Polychlorinated Biphenyls (PCBs) or Askarel, Trichlorobenzene, Perchloroethylene, Freon 113, and Paraffinic hydrocarbons (mineral oil, silicone oil). Fluid cost differences can vary significantly.

Sound levels of liquid-filled transformers are typically lower. However, when fans are used in the dry types, there is little difference in the audio sound levels of liquid-filled and dry-type transformers. Without the use of fans, liquid-filled units are 5 to 6 decibels (dB) quieter than dry-types. The particular site of the transformer is relevant as far as the tolerable sound or noise level. In office buildings, the level of sound is important; however, where the ambient sound level is already high, such as in a production facility, sound or noise level from a transformer is practically drowned out.

Liquid-filled transformers can be used indoors or outdoors. However, greater safety precautions are generally required. A limiting constraint is the maximum oil temperature. Damage to liquid-filled tanks can cause leaks or spills which could contaminate soil and ground water. Because of stringent national, state, and local building codes, oil-filled transformers generally require fireproof vaults with oil retaining pits. A non-propagating liquid-filled unit would require fire prevention measures such as a sprinkler system and a liquid retaining pit. The extra environmental protection needed in the case of liquid-filled transformers could increase installation costs.

Mineral Oil transformers require very little maintenance. A periodic check of the temperature and level of the insulating oil is all that is usually recommended. Moisture and oxygen affect the quality of the insulating oil. Moisture reduces the dielectric strength and oxygen helps form sludge. Isolation of the oil from the air by using an inert gas, such as nitrogen, above the surface of the oil in a sealed transformer tank eliminates this source of possible trouble.

Silicone transformers are generally safer and more efficient than oil-filled. This is because the silicone liquid is chemically inert reducing the need for maintenance. It is also less flammable with no combustible toxic by-products. It possesses high chemical stability and being a clear liquid it enables visual checks for foreign residues. It is also electrically and thermally very stable.

RTEmp transformers use a highly refined paraffinic oil that is biodegradable, non-bioaccumulating, and non-toxic. Unlike silicone, the units are usually smaller in size and weigh less. Like most liquid-filled transformers, RTEmp transformers can be used in damp, dusty, and corrosive environments unlike the ventilated dry-type transformers.

Amorphous core transformers are liquid-filled with mineral oil or silicone. This is an emerging technology, and is in the "maturity" stages of the product life cycle and has entered the commercialization phase. Amorphous core transformers are said to have no-load losses about one-third that of silicon steel losses. The technology is being applied in the lower kVA ratings (10-500 kVA) using wound core technology. Over the next few years, this new technology will be applied to higher kVA ratings using wound and stacked cores. The application to dry-type transformers will be made later on since the dry-type market at present does not typically justify the incremental cost of efficiency gains.

2.2 Dry Transformer Alternatives

Four types of dry transformer are considered. These are: Vapor-cooled (Freon 113, chloroflurocarbons); ventilated-dry (use of ambient air for cooling and dielectric strength); sealed-dry (use of fluorocarbon gas); and cast coil (windings are encapsulated in epoxy -Class F material - or polyester Class H).

Where the risks from accidental spills from liquid-filled transformers are high (eg. near and around agriculture or waterways), dry-type transformers are preferred. Initially, dry-type units were installed outdoors, but greater

flexibility in location is now possible. They can be hung from joists, located on rooftops, or simply placed along walls. In fact, given the extra hidden costs of regulatory compliance of needing vaults, the danger of spills, the flammability of most liquids in liquid-filled transformers, dry-type units can be just as good or better indoors as liquid-filled.

Vapor-cooled transformers usually contain liquid Freon 113. It is non-flammable and has no flashpoint, no firepoint, and is non-flammable in air. When rated 35 kv or below, these transformers can be installed indoors. However, proper ventilation is required as a precaution against vapor leaks. It is also possible that toxic gases such as chlorine and phosgene are produced during thermal decomposition and "arcing."

Also, checking of the dielectric in preventive maintenance is difficult, and care is needed for "cold starts" in temperatures below -20°F. It is comparably larger and heavier than most liquid-filled units.

Ventilated transformers can be used indoors or outdoors, They require a constant flow of clean, dry air to cool the windings. Generally, they are not used where core and coil may be exposed to corrosive fumes, liquids (dew) or severe dust.

Sealed dry-type transformers provide the necessary protection for core and coils in damp, dusty, and corrosive environments. Cast coil dry transformers, non-ventilated and sealed gas-filled units can be used also in severe and hostile environments.

Cast coil transformers have their windings encapsulated in epoxy - Class F material - or polyester - Class H. They cost and weigh more than comparable liquid-filled units. However, life cycle costs can be lower. The greater weight of the epoxy structure provides robustness and added strength against mechanical shock and vibration.

A cast coil transformer can be started cold, immediately switched on from a "de-energized" state even in humid conditions, which is a distinct advantage over other transformer types. As a consequence, no-load losses when the transformer is not in use can be avoided, thus reducing no-load loss and life cycle costs.

It has a high overload capacity as compared to liquid-filled units. This enables the cast coil to be overcharged for a short duration which is considerably greater than for oil-immersed transformers.

Generally, dry-type units require less maintenance. Annual cleaning by suction is sufficient. Cast coil has a fairly low noise level which makes it suitable for residential areas and buildings. However, the most distinct advantage of a cast coil transformer is that it can be readily switched on-and-off depending on usage, cutting down on no-load losses when not in use, which can result in lower life cycle costs.

2.3 Key Technical Parameters

There are a number of key technical parameters that affect costs related to purchasing, installing, operating, and maintaining transformers. They are:

- o Location and Environment
- o Transformer Weights, Dimensions, and Design
- o Electrical, Mechanical, Chemical, and Material Characteristics
- o Transformer Losses and Efficiency
- o Transformer Life Expectancy and Reliability (Failure Rate)
- o Distribution System Configuration (Load Cycles, Load Factor, etc.)

Some of the above parameters are interrelated. Important items not previously addressed will be stated below.

2.3.1 Reliability and Life Expectancy

Reliability and life expectancy are often a function of the transformer insulation system. Insulation failure is usually a function of heating which is caused by the loading practices of the user. Thus, deterioration of the insulation system is the result of temperature and time. When the Basic (insulation) Impulse Level (BIL) is reduced, the impedance rating is decreased and short-circuit current surges can then lead to winding insulation rupture.

Insulation breakdown is reported as the primary cause of failure, and most transformer failures are caused by factors not related to normal deterioration from age [3]. In surveys, it is estimated that only about 13% of the failures are attributed to normal wear and tear of transformer aging; the remaining 87% is due to poor maintenance, negligence, and unavoidable external causes. Transformer life expectancy under normal conditions can be in excess of 30-40 years. The life expectancy of a typical transformer can be statistically estimated using the so-called "bathtub" probability distribution

of failure, and from distributions in the statistical theory of reliability. These distributions are useful when "changeout" or replacement timing of transformers is considered. Exhibits 1 and 2 provide survey statistics of transformer failure [3]. Failure here is defined as any or any combination of the following:

- o partial or complete shutdown, or below standard operation
- o unacceptable performance of user's equipment
- o operation of the electrical protective relaying or emergency operation of the electrical system
- o de-energization of any electrical circuit or equipment

2.3.2 Load Losses, Voltage Class, and Efficiency

Perhaps the most important physical parameter that directly affects life cycle costs is that of power losses. There are 4 kinds of losses. They are: load losses, no-load losses, reactive losses, and regulation losses.

Load losses are caused by electrical resistance in the transformer windings. Load losses are referred to as I^2R losses or "winding" losses. Losses vary with the square of the load current. Transformers having the largest conductor (greater capacitance or lower resistance) will have the lowest load loss for the same load. Load losses occur primarily at peak load periods.

No-load losses are core losses which represent the energy required to magnetize the transformer core. Transformers with larger conductors (lower thermal ratings) require larger cores and have larger no-load losses. Core losses are constant and are independent of the load. Typically, liquid-filled units have smaller cores and consequently have low no-load losses. Ventilated dry-type transformers have higher no-load loss because they require larger cores.

Reactive losses are a measure of the efficiency of design and management of reactive volts-amps or VAR.

Regulation losses are caused by the voltage drop as current flows in the transformer. Regulation losses like reactive losses are typically insignificant, and often ignored in cost evaluations. Compared to total transformer and power loss costs, regulation loss cost is less than 3.0% [4].

Voltage class is another important parameter. For dry-type transformers, voltage classes up to 34.5 KV with BILs up to and above 150 KV have been found to be suitable in certain applications. Houston Lighting & Power Co., for example, found that increasing distribution voltage from 12.47 KV to 34.5 KV reduced transmission costs by 32.5% and substation costs by 24.3%. Power losses in a typical circuit were reduced by 85% [5]. A typical load center transformer has the following characteristics: 1500 kva; 95 kV BIL; 13.8 KV; good overload capacity; and 98.5% efficiency. It is important that transformers be corona-free at working voltages, since corona effects interfere with radio frequency and TV.

Efficiency is a measure of effectiveness or performance. With respect to transformers, it is the energy out of the transformer expressed as a percentage of the energy into the transformer. Efficiency significantly varies with loading conditions. Dry-type transformers where a loss ratio (Full Load Loss/No-Load Loss) of nearly 1 implies loading at 100% rating for maximum efficiency, liquid-filled transformers having loss ratio of nearly 4 to 6 implies 50-75% loading for maximum efficiency. Exhibit 3 shows some typical efficiency curves.

2.3.3 Load Duty Cycle

Load Duty Cycle is an important parameter. Exhibit 4 shows typical load profiles. Life expectancy and efficiency depend on them. Loads must be evaluated in terms of the **"hot spot"** temperature of the windings. The hot spot temperature represents the worst (highest) temperature the insulation system is subjected to. The hot spot temperature is the sum of the ambient temperature, the winding temperature rise, and the hot spot gradient. The ambient temperature is not a function of loading, but the winding temperature and the hot spot gradient are directly related to loading. Since transformer life is a function of temperature and time, a parameter such as the **"winding time constant"** establishes the thermal curve for the windings with respect to time. By definition, the winding time constant is the time required for the winding to attain 63% of its total temperature rise starting at zero load with rated voltage, frequency, and load applied.

The smaller the winding time constant, the sooner the transformer's windings will reach the continuous temperature rise for a given load. The hot spot gradient also follows the same thermal curve as the winding temperature rise. Each load will generate a different thermal curve. Exhibit 5 provides a graphical view of a typical thermal curve for the transformer windings with respect to time. The bottom part of the exhibit shows a superimposition of the

load duty cycle and the hot spot temperature curve, which represents the relationship of the two. The average time constant with aluminum windings is generally about half the time for copper windings. Aluminum windings are sometimes used since they are lighter than copper - the specific gravity of aluminum is only about 30% of copper - and are not subject to volatile price fluctuations. However, the electrical conductance of aluminum is only about 63% that of copper.

From an economic perspective, it might be necessary that transformers be purchased in a size that is determined on the basis of its load loss/no-load loss ratio with the average load near the point of maximum efficiency, which may be 50-75% of its rated output. Needless to mention that load duty cycles are very important, yet other economic parameters like the interest rate, cost of energy, etc. also impact the economics of transformer alternatives.

Exhibits 6 and 7 provide basic physical data on the transformer alternatives used in this comparison.

Exhibit 1

INITIATING COMPONENT FAILURE

COMPONENT	FAILURE %
Winding insulation breakdown	29.1
Transient overvoltage disturbance (switching surges, arching ground fault, etc)	16.4
Insulation bushing breakdown	13.6
Mechanical breaking, cracking, loosening, abroding or deforming of static or structural parts	7.3
Loose connection or termination	7.3
Other insulation breakdown	5.4
Malfunction of protective relay control device or auxiliary device	4.5
Improper operating procedure	3.6
Overheating	2.7
Mechanical burnouts, friction or seizing of moving parts	2.7
Mechanically caused damage from foreign source	2.7
Shorting by birds, snakes, rodents, etc.	2.7
Shorting by tools or other metal objects	0.9
Continuous overvoltage	0.0
Others	0.9

Exhibit 2

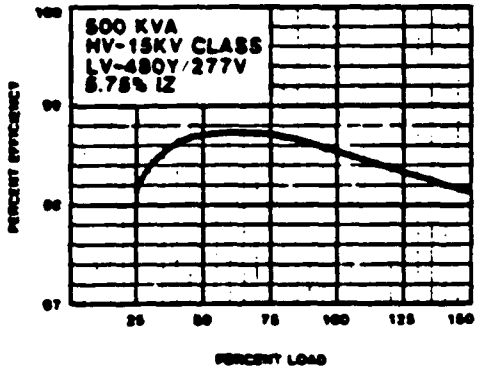
FAILURE CONTRIBUTING CAUSE

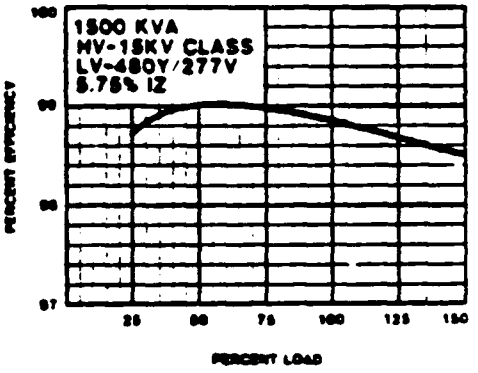
CAUSE	FAILURE %
Persistent overloading	1.1
Abnormal temperature	5.5
Exposure to aggressive chemicals, solvents, dust, moisture or other contaminants	14.4
Normal deterioration from age	13.3
Severe wind, rain, snow, sleet or other weather condition	4.4
Lack of protective device	2.2
Malfunction of protective device	7.8
Loss, deficiency, contamination or	10.0
Improper operating procedure or testing error	3.3
Inadequate maintenance degradation of oil	7.8
Exposure to non-electrical fire or burning	0.0
Obstruction of ventilation by foreign object or material	0.0
Improper setting of protective device	0.0
Inadequate protective device	0.0
Others	30.0

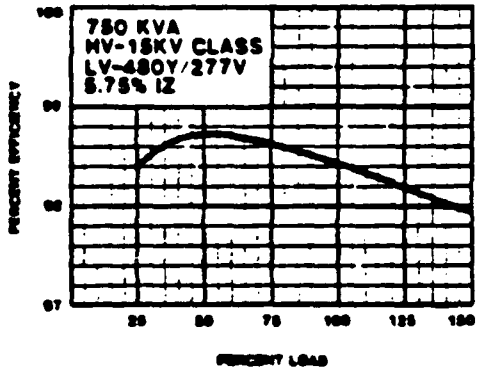
Exhibit 3

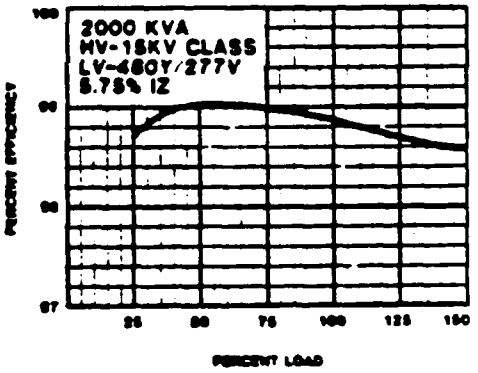
TYPICAL EFFICIENCY:

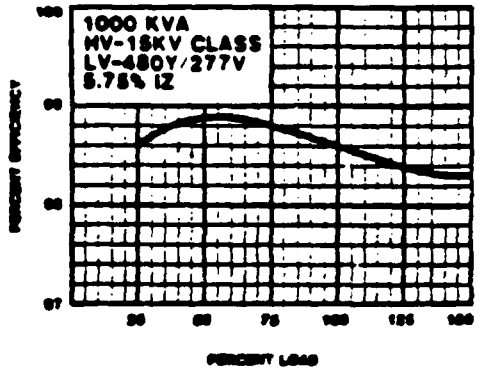
Efficiency is the energy out of the transformer expressed as a percentage of the energy into the transformer. The following curves are representative of typical efficiency characteristics.











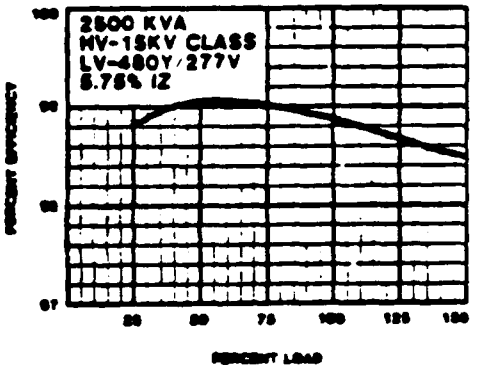
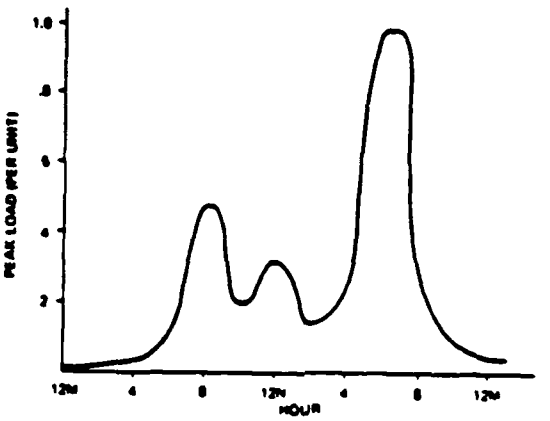
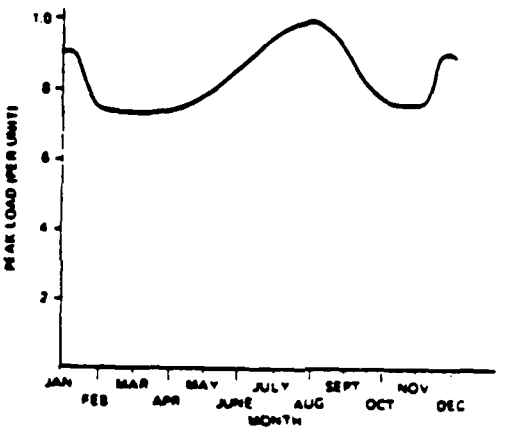


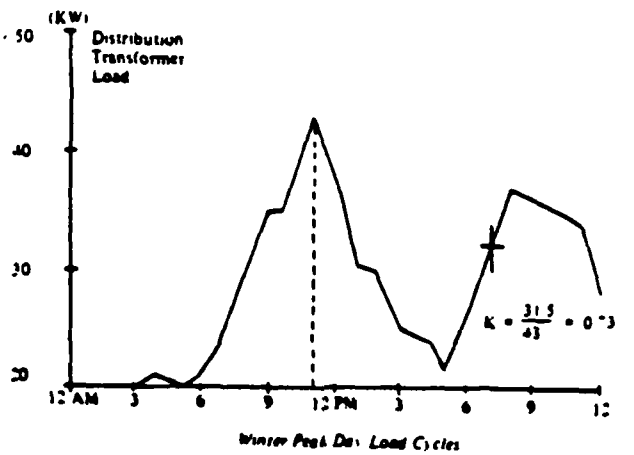
Exhibit 4



Daily Transformer Load Cycle.



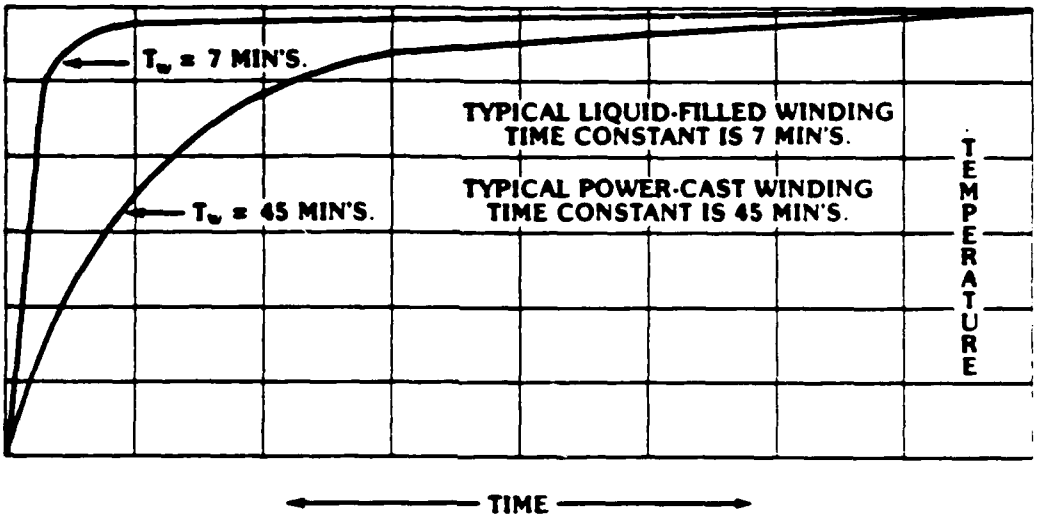
Annual Transformer Load Cycle.



Winter Peak Day Load Cycles

WINDING TIME CONSTANT

The winding time constant establishes the thermal curve for the windings with respect to time. The following figure shows a comparison of the thermal curves for a typical liquid-filled transformer's windings vs a Power-Cast's windings at rated load.



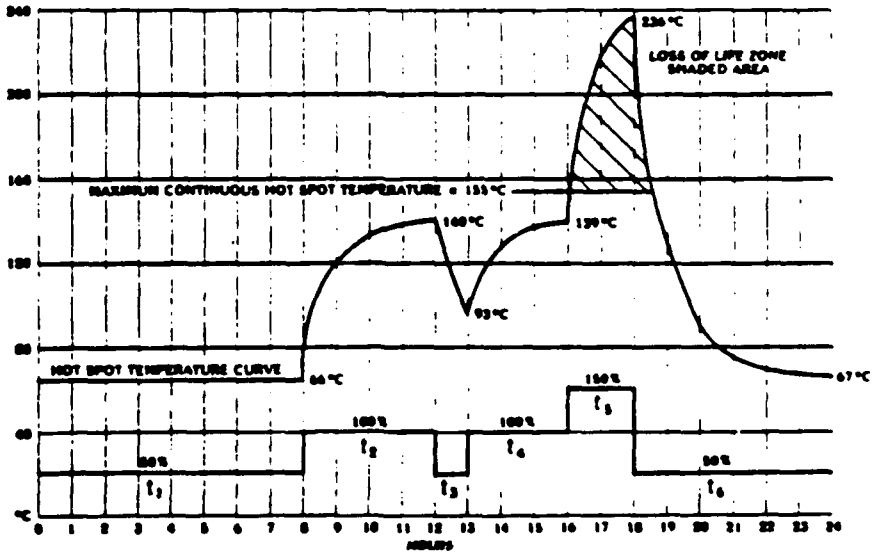


Exhibit 6

BASIC PHYSICAL DATA

TRANSFORMER TYPE	TEMP. RISE(oC)	BIL (kV)	NO-LOAD LOSS(kw)	LOAD LOSS(kw)	FAILURE RATE(%)
		25 kVA			
Mineral Oil	65	95	0.060	0.220	0.3
Silicone	65	95	0.060	0.220	
RTEmp	65	95	0.060	0.220	
Amorphous Core	65	95	0.018	0.242	0.2
Vapor-cooled	--	--	----	---	--
Ventilated-dry	--	--	----	---	--
Sealed-dry	--	--	----	---	--
Cast Coil	100	95	0.350	1.200	0.1
		75 kVA			
Mineral Oil	65	95	0.131	0.609	0.3
Silicone	65	95	0.131	0.609	0.2
RTEmp	65	95	0.131	0.609	0.2
Amorphous Core	65	95	0.037	0.745	0.2
Vapor-cooled	--	--	---	---	--
Ventilated-dry	--	--	---	---	--
Sealed-dry	--	--	---	---	--
Cast Coil	100	95	0.450	1.800	0.1
		150 kVA			
Mineral Oil	65	95	0.291	1.097	0.3
Silicone	65	95	0.291	1.097	0.2
RTEmp	65	95	0.291	1.097	0.2
Amorphous Core	65	95	0.099	1.122	0.2
Vapor-cooled	--	--	---	---	--
Ventilated-dry	--	--	---	---	--
Sealed-dry	--	--	---	---	--
Cast Coil	100	95	0.800	2.600	0.1
		300 kVA			
Mineral Oil	65	95	0.535	1.786	0.3
Silicone	65	95	0.535	1.786	0.2
RTEmp	65	95	0.535	1.786	0.2
Amorphous Core	65	95	0.165	1.857	0.2
Vapor-cooled	--	--	---	---	--
Ventilated-dry	--	--	---	---	--
Sealed-dry	--	--	---	---	--
Cast Coil	100	95	1.100	3.700	0.1

NOTE: All losses are not guaranteed, but are typical estimates. Failure rates are based on NEMA statistics.

Exhibit 7

BASIC PHYSICAL DATA

TRANSFORMER TYPE	TEMP. RISE(°C)	BIL (kV)	NO-LOAD LOSS(kw)	LOAD LOSS(kw)	FAILURE RATE(%)
		500 kVA			
Mineral Oil	65	95	0.610	3.153	0.3
Silicone	65	95	0.610	3.153	0.2
RTEmp	65	95	0.610	3.153	0.2
Amorphous Core	65	95	0.230	3.192	0.2
Vapor-cooled	45	95	1.400	5.400	0.5
Ventilated-dry	80	95	3.500	5.700	1.2
Sealed-dry	--	--	---	---	--
Cast Coil	100	95	1.700	6.200	0.1
		750 kVA			
Mineral Oil	65	95	0.897	4.388	0.3
Silicone	65	95	0.897	4.388	0.2
RTEmp	65	95	0.897	4.388	0.2
Amorphous Core	65	95	0.314	4.399	0.2
Vapor-cooled	45	95	1.816	5.814	0.5
Ventilated-dry	80	95	4.600	7.700	1.2
Sealed-dry	120	95	3.000	9.000	0.2
Cast Coil	100	95	2.100	7.800	0.1
		1000 kVA			
Mineral Oil	65	95	1.033	5.843	0.3
Silicone	65	95	1.033	5.843	0.2
RTEmp	65	95	1.033	5.843	0.2
Amorphous Core	65	95	0.400	5.484	0.2
Vapor-cooled	45	95	1.861	8.520	0.5
Ventilated-dry	80	95	6.000	8.200	1.2
Sealed-dry	120	95	3.900	11.900	0.2
Cast Coil	100	95	2.800	8.100	0.1
		1500 kVA			
Mineral Oil	65	95	1.409	8.934	0.3
Silicone	65	95	1.409	8.934	0.2
RTEmp	65	95	1.409	8.934	0.2
Amorphous Core	65	95	0.568	7.213	0.2
Vapor-cooled	45	95	2.269	11.132	0.5
Ventilated-dry	80	95	8.000	9.600	1.2
Sealed-dry	120	95	5.000	11.500	0.2
Cast Coil	100	95	3.800	11.000	0.1

NOTE: All losses are not guaranteed, but are typical estimates. Failure rates are based on NEMA statistics.

COST COMPARISONS OF TRANSFORMER ALTERNATIVES

3.1 Key Cost Parameters

Like the technical parameters stated in the previous section, there are a number of key cost and economic parameters.

"Cost" has a larger connotation in the economic sense than in the engineering use of it. From a purely cost-benefit point of view, "cost" can be defined, more generally, as adverse impacts, and "benefits" as desirable impacts.

"Cost" can be construed in several contexts or categories, such as: direct or indirect; intended or unintended; short-term or long-term; quantifiable and unquantifiable; tangible or intangible; certain or probabilistic; internal or external.

The scope of this analysis is limited (narrowly) only to a few direct (engineering-type) costs and a deterministic evaluation of life cycle costs. Aspects of risk and uncertainty relating to technical and cost parameters are ignored. Key cost parameters are the following:

- **Environmental** costs (record-keeping; special handling and disposal of spills; compliance of national, state, and local regulations and laws, such as the Resource Conservation and Recovery Act, Clean Water Act; etc.)

- **Purchase or Bid Price** of the transformer (may be dependent on quantity discounts, "special" customers, etc.)

- **Transportation Cost** (special handling and freight; transformers are heavy and weigh several thousands of pounds)

- **Installation Cost** (might be contingent on indoor or outdoor application, special site requirements; usually oil-filled transformers when installed indoors will require a fireproof vault with oil retaining pit; a non-propagating liquid-filled unit would require a fire prevention sprinkler system and a liquid retaining pit to meet insurance, national, state, and local building codes; usually dry-type units require lower installation costs for indoor applications)

- **Maintenance, Reliability, and Repair Costs** (might be higher for liquid-filled than dry-type transformers; outage or downtime cost related to lost production or interrupted activity and backup/emergency procedures)

- **Operating Cost** (this is primarily to do with load and no-load losses, regulation and reactive losses; load duty cycle is important for load loss evaluation as discussed in section 2.3.3)

- **System Investment Cost** (Plant generation cost; transmission and distribution costs - primary distribution lines (overhead and underground), distribution substations, etc.)

- **Fixed and Switched Capacitor Cost** (no-load and load reactive losses for distribution transformers are usually supplied by fixed and switched capacitors respectively, which are installed on the primary distribution feeders)

3.2 Key Economic Parameters

Key economic parameters are the following:

- **Escalator rate for energy cost.** The unit cost of energy will depend on real supply-demand changes over time (in the case of transformers the timespan is over 30-40 years which makes forecasting difficult, if not impossible) and general inflationary expectations, which might also prove to be just as risky and uncertain. The electricity price is a relative price in that it is elastic to the price of oil. Since a barrel of world oil is denominated in U.S dollars, the price of oil has recently fallen both in nominal and real terms because of temporary world oil surplus, a depreciating U.S. dollar on world currency exchanges, and U.S. inflation. The price of electricity might still rise due to a growing dependence on nuclear power, where environmental regulations and long delays in nuclear plant construction translate into increased costs that will be reflected in the rate base.

- **Escalator rate for labor and materials** would generally be reflected in the purchase price of the transformer; however, because of purchase delays and market volatility in the price of commodities, such as copper, aluminum, and chemicals, planning and implementation of purchase and replacement strategies become difficult.

- **Rate of Technological Development** is also relevant to the scheduling decision of buying now or postponing the purchase until such time that new and better technology becomes available. To address this problem, a technological assessment would be needed.

- **Interest or discount rate (the cost of capital)** is required for computing the present values of life cycle costs. For this purpose, a nominal risk-free discount rate of 10% is used as the government's cost of capital. Nominal dollars rather than real (or constant) dollars are used throughout the evaluation.

3.3 Key Assumptions

The following **assumptions** are made for computing life cycle costs.

- 25 kVA rated transformers are single-phase; all others are three-phase.

- All estimates are point ("most likely" or average) estimates. Interval or, still better, probability distributions, whether subjective or objective, would provide a more rigorous and realistic basis from which practical conclusions may be drawn. However, this would entail methodologies of risk and uncertainty which go beyond the scope of this effort.

- A time span (life cycle or life expectancy) of 30 years is assumed for all transformers. This is a reasonable assumption supported by historical data. However, this life cycle or, more precisely, the physical life cycle is also assumed to be coincident with the economic life cycle and product life cycle of all the different types of transformers.

- There will be no failures, outages, downtime, or repairs (100% operating reliability) during the life cycle of 30 years.

- Transformers are assumed to be operated at 50% of full load (nameplate rating) of each transformer. This is the average loading estimate at Norfolk Naval Base. However, some transformers may be operating as low as 10% of nameplate rating and others as high as 90%.

- There are several sizes (kVA) of transformers in the PWC-Norfolk and NSY-Norfolk. Histograms showing the variation in kVA size are given in Exhibit 8. For the purpose of this effort, the kVA sizes considered are: 25, 75, 150, 300, 500, 750, 1000, 1500.

- All prices (costs) are in current (end-of-year) 1988 or nominal U.S. dollars.

- A risk-free, constant discount (or interest) rate of 10% compatible with government guidelines is used.

- The escalator rate for the unit cost of energy ($/kwh) is assumed to be 5% consistent only with the projected rate of inflation of 5% over the long-term, ie. 30 years. In other words, the cost of energy will be pegged only to the rate of general inflation, while excluding any supply/demand changes in the price of energy. If energy costs were to increase from $0.06/kwh to $0.12/kwh, life cycle savings would increase dramatically, from 102% to 125%, and the payback period (years) would decrease by 50% depending on the size and load rating of the transformer.

- Optimum kVA size selection for each transformer for each particular application is tacitly assumed.

- Transportation, installation and maintenance costs will depend on a set of unique characteristics governed by the special needs of each location. In-place maintenance, operating practices, and particular applications will vary considerably from site to site. The number of variables involved make the use of these statistics impractical in determining life cycle costs.

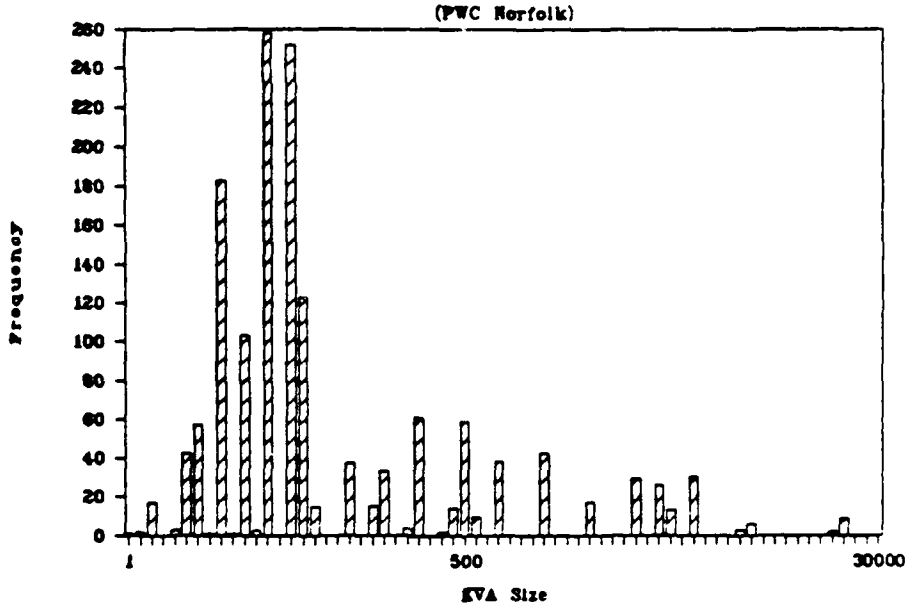
- Reactive and Regulation power losses are ignored, as in most evaluations of cost, since they constitute less than 3% of total costs.

- Because of the multiplicity of transformer designs, some of which are custom-designed, standardization might be only approximate. Thus, true comparisons with reference to any standard will be subject to some bias.

- Transformer prices will remain constant, which might be hard to defend if purchasing delays are anticipated. Since raw material inputs, such as copper, might be subject to market forces, changes in market prices of such inputs will be reflected in the purchase price. However, any price increase is simply added to the life cycle cost and any decrease in price is subtracted to update the life cycle cost of any transformer.

Exhibit 8

Transformer Distribution By KVA Size



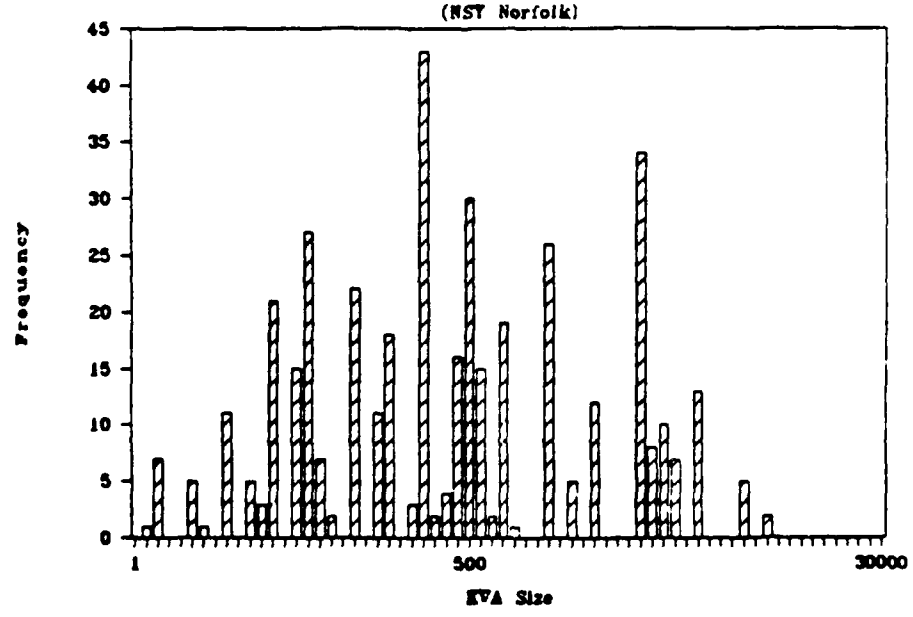
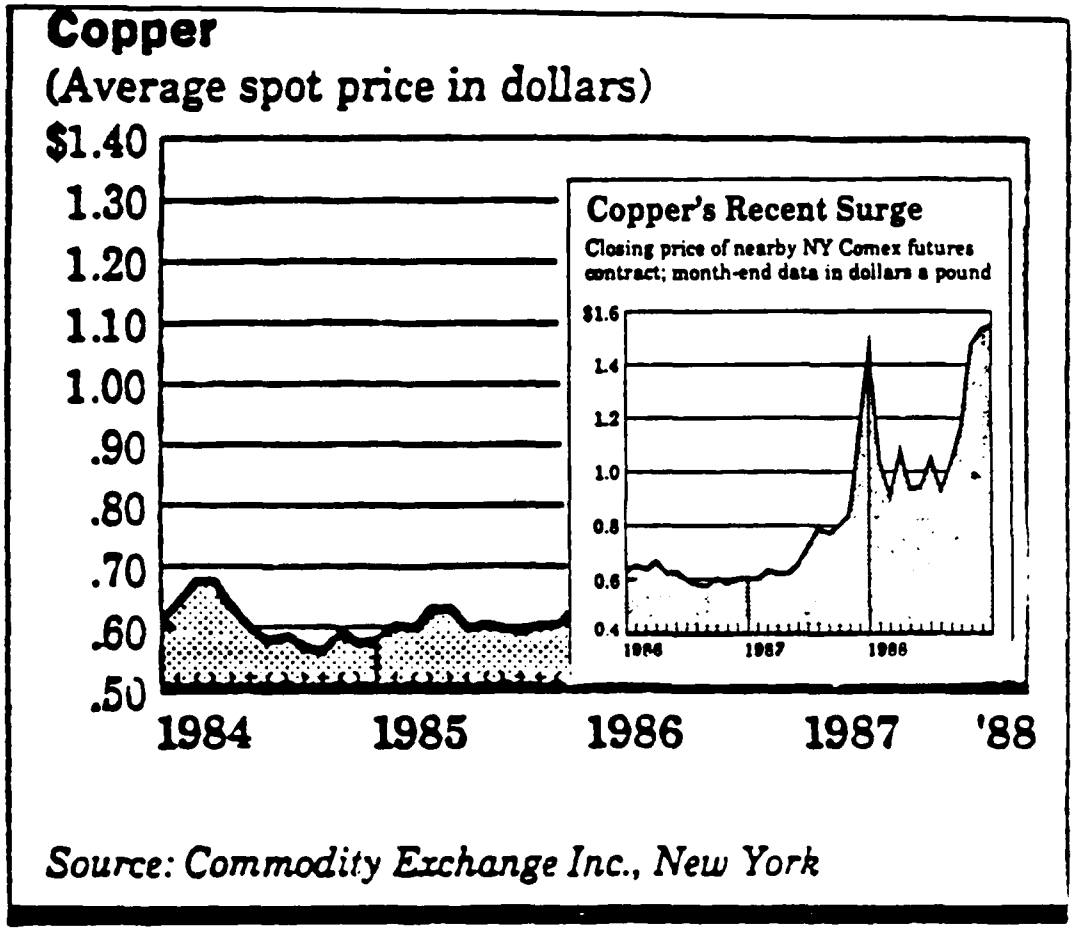


Exhibit 9



Source: Commodity Exchange Inc., New York

GRAIN-ORIENTED SILICON STEEL

Grain-oriented silicon steel is used in the fabrication of cores. While the production costs of grain-oriented silicon materials have generally been rising since 1984, the actual transaction sales prices of finished product to manufacturers of transformers have been depressed from listed prices.

However, these transaction prices in 1988 are beginning to rise to the level of actual production costs of fabricating grain-oriented silicon materials for manufacturing cores.

Actual transaction prices of grain-oriented silicon finished products to manufacturers of transformers are proprietary for competitive reasons.

3.4 Life Cycle Cost Model

The cost model takes the form of a typical "cash flow" that spans 30 years, which is the assumed life cycle of all transformers under consideration. The total Life Cycle Cost (LCC) is given by the equation shown below. Expressions for No-Load and Load losses are also given below. Non-recurring costs consists of just the purchase price, and recurring costs are Load and No-load costs.

Life Cycle Cost = Purchase Price + No-Load Loss Cost + Load Loss Cost

No-Load Loss Cost ($) = Energy Cost ($/kwh) * No-Load Loss (kw) * 8760
(8760 = Total number of hours in the year)

Load Loss Cost ($) = Energy Cost * [Operating Load/Nameplate Rating]^2 * Load Loss * 8760

Transportation (shipping and handling) and installation costs are not considered in this analysis, because these costs vary widely and are heavily dependent on location and site specifics. Also, national, state, and local environmental and building codes have different requirements and applicability. For example, an oil transformer installed indoors might require a fireproof vault with an oil retaining pit and fire-prevention sprinkler system. By comparison, dry transformers generally require far lesser installation cost. For a "normal" location and site, a rough estimate of $200 per transformer for installation can be assumed. This can be simply added to the life cycle cost.

Maintenance costs for distribution transformers are assumed to be zero or negligible.

Load and no-load losses are the most significant operating cost factors. No-load losses are constant and do not vary with loading. Load (or copper, windings, I^2R) losses are usually much greater than no-load losses, but these losses vary as the square of the change in loading. For example [6], a unit with 10 kW of losses at full load, when operated at 50% of full load will only have 25% of the full load loss.

Suppose the transformer has 10 kW of load losses when operated at 1000 kVA (nameplate rating), and one wishes to know what losses may be expected when this unit is operated at 500 kVA. The computation is given below.

Load Losses = (500/1000)2* 10 kW
= 2.5 kW or 25% (Note: 500/1000 or 50% is the Load Rating)

Conversely, the same unit operated at 1,333 kVA will have the following losses.

Load Losses = $(1333/1000)^2$ * 10 kW
= 17.769 kW

which indicates that losses have increased 77.69% for a 33.3% increase over the nameplate rating. Overloading does significantly increase losses. However, continuous overloading is usually not the case. If the transformer, on the other hand, is usually underloaded, then it is clear from the numerical example above that load losses are reduced as the inverse square, and no-load losses gain in importance since they are independent of whatever load.

3.5 Life Cycle Cost Comparisons

Transformer prices are shown in Exhibit 10. Life Cycle Costs summaries are given in Exhibits 11 through 14. The present values of these life cycle costs are also included.

Potential life cycle savings of amorphous metal core transformers over conventional silicon transformers are shown in Exhibits 15 through 17. Life cycle savings are shown at $0.06/kwh and $0.12/kwh for 10%, 50% and 90% load ratings. Price differentials are at 15% and 30%.

Payback periods for recouping the extra investment cost (price differential) of amorphous core transformers over silicon transformers by the expected savings in load and no-load costs are also given. Graphical examples of life cycle savings and payback periods for 25 kVA, 300 kVA, 1000 kVA, and 1500 kVA transformers are shown in Exhibits 18 and 19.

Exhibit 10

TRANSFORMER PRICE LIST

TRANSFORMER TYPE (See Note 6 below)	PRICES (1988$) 25 kVA	75 kVA	150 kVA	300 kVA
Mineral Oil	650	2,300	6,200	10,500
Silicone	884	7,616	8,432	14,280
RTEmp	871	7,504	8,308	14,070
Amorphous Core	800	2,990	8,060	13,650
Vapor-cooled	---	-----	-----	------
Ventilated-dry	---	-----	-----	------
Sealed-dry	---	-----	-----	------
Cast Coil	11,769	12,242	14,420	20,644

TRANSFORMER TYPE	PRICES (1988$) 500 kVA	750 kVA	1000 kVA	1500 kVA
Mineral Oil	12,600	14,600	17,900	21,500
Silicone	17,136	19,856	24,344	29,240
RTEmp	16,884	19,564	23,986	28,810
Amorphous Core	16,380	18,980	23,270	27,950
Vapor-cooled	17,000	18,500	19,200	22,600
Ventilated-dry	20,100	21,500	24,300	32,300
Sealed-dry	------	49,600	55,600	67,100
Cast Coil	25,094	32,107	37,323	51,600

NOTES

1. List prices of mineral oil, silicone, and amorphous core transformers are based on "quantity discounts" of at least 10 identical transformers that must be purchased in order to obtain the discounted prices.
2. Prices of amorphous core transformers are 30% higher than those of mineral oil transformers. The price gap is expected to narrow to about 15% in the next 5 years or so.
3. Purchase prices quoted here are average price estimates, which are subject to variation depending on design and manufacturing improvements and productivity, inflation, supply-demand and general market conditions at the time of purchase.
4. Prices quoted here do not include shipping, handling, and installation, as these relate to particular customer requirements, location, and site specifics. A rough estimate of about $200 per transformer can be assumed for shipping, handling, and installation for a "normal" operation.
5. Prices are valid only for standard HV/LV ratings, percent impedances (eg. 4.4), reference temperatures (eg. 65°C rise), standard design and typical loss data.
6. All transformer types are 3-phase, except for 25 kVA transformers.

Exhibit 11

LIFE CYCLE COSTS SUMMARY

TRANSFORMER TYPE	PURCHASE PRICE ($)	NO-LOAD LOSS COST($)/PV	LOAD LOSS COST($)/PV	TOTAL COST($)/ PV
(25 kVA Transformers)				
Mineral Oil	650	2,095 475	1,921 435	4,666 1,559
Silicone Oil	884	2,095 475	1,921 435	4,900 1,793
RTEmp	871	2,095 475	1,921 435	4,887 1,780
Amorphous Core	800	629 142	2,113 478	3,541 1,421
Vapor-cooled	---	---	---	-----
Ventilated Dry	---	---	---	-----
Sealed Dry	---	---	---	-----
Cast Coil	11,769	12,222 2,768	10,476 2,373	34,467 16,909
(75 kVA Transformers)				
Mineral Oil	2,300	4,575 1,036	5,317 1,204	12,191 4,540
Silicone Oil	7,616	4,575 1,036	5,317 1,204	17,507 9,857
RTEmp	7,504	4,575 1,036	5,317 1,204	17,395 9,744
Amorphous Core	2,990	1,292 293	5,544 1,255	9,826 4,538
Vapor-cooled	-----	-----	-----	-----
Ventilated Dry	-----	-----	-----	-----
Sealed Dry	-----	-----	-----	-----
Cast Coil	12,242	15,714 3,559	15,714 3,559	43,670 19,360

Exhibit 12

LIFE CYCLE COSTS SUMMARY

TRANSFORMER TYPE	PURCHASE PRICE ($)	NO-LOAD LOSS COST($)/PV	LOAD LOSS COST($)/PV	TOTAL COST($) /PV
(150 kVA Transformers)				
Mineral Oil	6,200	10,162	9,577	25,939
		2,301	2,169	10,670
Silicone Oil	8,432	10,162	9,577	28,171
		2,301	2,169	12,902
RTEmp	8,308	10,162	9,577	28,047
		2,301	2,169	12,778
Amorphous Core	8,060	3,457	9,795	21.312
		783	2,218	11,061
Vapor-cooled	-----	-----	-----	------
Ventilated Dry	-----	-----	-----	------
Sealed Dry	-----	-----	-----	------
Cast Coil	14,420	27,936	22,698	65,054
		6,327	5,140	25,887
(300 kVA Transformers)				
Mineral Oil	10,500	18,682	15,592	44,774
		4,231	3,531	18,262
Silicone Oil	14,280	18,682	15,592	48,554
		4,231	3,531	22,042
RTEmp	14,070	18,682	15,592	48,344
		4,231	3,531	21,832
Amorphous Core	13,650	5,762	16,212	35,624
		1,305	3,671	18,626
Vapor-cooled	------	-----	-----	------
Ventilated Dry	------	-----	-----	------
Sealed Dry	------	-----	-----	------
Cast Coil	20,644	38,412	32,301	91,358
		8,699	7,315	36,658

Exhibit 13

LIFE CYCLE COSTS SUMMARY

TRANSFORMER TYPE	PURCHASE PRICE ($)	NO-LOAD LOSS COST($)/PV	LOAD LOSS COST($)/PV	TOTAL COST($) /PV
(500 kVA Transformers)				
Mineral Oil	12,600	21,301	27,526	61,427
		4,824	6,234	23,658
Silicone Oil	17,136	21,301	27,526	65,963
		4,824	6,234	28,194
RTEmp	16,884	21,301	27,526	65,711
		4,824	6,234	27,942
Amorphous Core	16,380	8,032	27,866	52,278
		1,819	6,311	24,510
Vapor-cooled	17,000	48,888	47,142	113,031
		11,072	10,676	38,748
Ventilated Dry	20,100	122,221	49,761	192,082
		27,679	11,269	59,049
Sealed Dry	------	------	------	------
Cast Coil	25,094	59,364	54,126	138,585
		13,444	12,258	50,796
(750 kVA Transformers)				
Mineral Oil	14,600	31,323	38,308	84,231
		7,094	8,675	30,369
Silicone Oil	19,856	31,323	38,308	89,487
		7,094	8,675	35,625
RTEmp	19,564	31,323	38,308	89,195
		7,094	8,675	35,333
Amorphous Core	18,980	10,965	38,404	68,349
		2,483	8,697	30,160
Vapor-cooled	18,500	63,415	50,757	132,672
		14,362	11,495	44,356
Ventilated Dry	21,500	160,633	67,221	249,355
		36,378	15,224	73,102
Sealed Dry	49,600	104,761	78,571	232,931
		23,725	17,794	91,119
Cast Coil	32,107	73,333	68,095	173,534
		16,608	15,421	64,136

Exhibit 14

LIFE CYCLE COSTS SUMMARY

TRANSFORMER TYPE	PURCHASE PRICE ($)	NO-LOAD LOSS COST($)/PV	LOAD LOSS COST($)/PV	TOTAL COST($) /PV
(1000 kVA Transformers)				
Mineral Oil	17,900	36,073	51,010	104,982
		8,169	11,552	37,621
Silicone Oil	24,344	36,073	51,010	111,426
		8,169	11,552	44,065
RTEmp	23,986	36,073	51,010	111,068
		8,169	11,552	43,707
Amorphous Core	23,270	13,968	47,876	85,114
		3,163	10,842	37,276
Vapor-cooled	19,200	64,987	74,380	158,567
		14,717	16,845	50,762
Ventilated Dry	24,300	209,552	71,587	305,408
		47,450	16,212	87,962
Sealed Dry	55,600	136,189	103,888	295,677
		30,843	23,527	109,970
Cast Coil	37,323	97,777	70,714	205,813
		22,143	16,014	75,481
(1500 kVA Transformers)				
Mineral Oil	21,500	49,203	77,994	148,697
		11,143	17,663	50,306
Silicone Oil	29,240	49,203	77,994	156,437
		11,143	17,663	58,046
RTEmp	28,810	49,203	77,994	156,007
		11,143	17,663	57,616
Amorphous Core	27,950	19,835	62,970	110,755
		4,492	14,261	46,703
Vapor-cooled	22,600	79,234	97,183	199,017
		17,944	22,009	62,553
Ventilated Dry	32,300	279,362	83,809	395,471
		63,267	18,980	114,547
Sealed Dry	67,100	174,601	100,396	342,097
		39,542	22,736	129,378
Cast Coil	51,600	132,697	96,031	280,328
		30,052	21,748	103,400

Exhibit 15

SAVINGS: AMORPHOUS METAL OVER CONVENTIONAL SILICON

(@ 15% Price Differential; Load Rating @ 10% Nameplate)

kVA	Price Differential ($)	Life Cycle Savings ($)		PV Savings ($)		Payback (Years)	
		6c/kwh	12c/kwh	6c/kwh	12c/kwh	6c/kwh	12c/kwh
25	98	1,361	2,820	233	563	4-5	2-3
75	345	2,928	6,202	396	1,138	6-7	3-4
150	930	5,766	12,462	586	2,103	7-8	4-5
300	1,575	11,321	24,216	1,345	4,266	6-7	3-4
500	1,890	11,366	24,622	1,112	4,114	7-8	4-5
750	2,190	18,165	38,519	2,420	7,029	6-7	3-4
1000	2,685	19,545	41,775	2,349	7,384	6-7	3-4
1500	3,225	26,744	56,713	3,562	10,349	6-7	3-4

(@ 30% Price Differential; Load Rating @ 10% Nameplate)

kVA	Price Differential ($)	Life Cycle Savings ($)		PV Savings ($)		Payback (Years)	
		6c/kwh	12c/kwh	6c/kwh	12c/kwh	6c/kwh	12c/kwh
25	195	1,264	2,723	135	466	7-8	4-5
75	690	2,583	5,857	51	793	10-11	6-7
150	1,860	4,836	11,532	(344)	1,173	13-14	7-8
300	3,150	9,746	22,641	(230)	2,691	12-13	6-7
500	3,780	9,476	22,732	(778)	2,224	13-14	7-8
750	4,380	15,975	36,329	230	4,839	11-12	6-7
1000	5,370	16,860	39,090	(336)	4,699	12-13	6-7
1500	6,450	23,519	53,488	337	7,124	11-12	6-7

NOTES:

1. The 15% Price Differential of Amorphous Core Metal transformers over Silicon Steel transformers applies to mid-1990s projected prices based on current silicon steel transformer prices. This narrowing of the price gap will result with further advanced technology, productivity improvements in manufacturing processes, and economies-of-scale.

2. The 30% Price Differential of Amorphous Core Metal transformers over Silicon Steel transformers represents quantity discounts (marginal cost pricing or "price leverage") on at least 10 transformers with identical design and characteristics purchased in 1989.

3. Prices of transformers are subject to a high degree of volatility based on the world market price of copper (which has risen from nearly 60 cents per pound at the beginning of 1987 to $1.65 in December 1988), shifts in supply-demand for certain types of transformers than others, general inflation, and technology improvements. Since product life cycles are getting smaller than physical or economic life cycles resulting from constantly changing technology improvements, competetiveness in the marketplace has increased which favors consumers (buyers).

Exhibit 16

SAVINGS: AMORPHOUS METAL OVER CONVENTIONAL SILICON

(@ 15% Price Differential; Load Rating @ 50% Nameplate)

kVA	Price Differential ($)	Life Cycle Savings ($) 6c/kwh	Life Cycle Savings ($) 12c/kwh	PV Savings ($) 6c/kwh	PV Savings ($) 12c/kwh	Payback (Years) 6c/kwh	Payback (Years) 12c/kwh
25	98	1,177	2,452	191	480	4-5	2-3
75	345	2,711	5,766	347	1,039	6-7	3-4
150	930	5,556	12,043	539	2,008	7-8	4-5
300	1,575	10,726	23,026	1,211	3,996	7-8	3-4
500	1,890	11,039	23,968	1,038	3,966	8-9	4-5
750	2,190	18,072	38,335	2,399	6,988	6-7	3-4
1000	2,685	22,554	47,792	3,031	8,747	6-7	3-4
1500	3,225	41,167	85,560	6,828	16,882	4-5	2-3

(@ 30% Price Differential; Load Rating @ 50% Nameplate)

kVA	Price Differential ($)	Life Cycle Savings ($) 6c/kwh	Life Cycle Savings ($) 12c/kwh	PV Savings ($) 6c/kwh	PV Savings ($) 12c/kwh	Payback (Years) 6c/kwh	Payback (Years) 12c/kwh
25	195	1,080	2,354	94	382	8-9	4-5
75	690	2,366	5,421	2	694	11-12	6-7
150	1,860	4,620	11,113	(391)	1,078	13-14	7-8
300	3,150	9,151	21,451	(364)	2,421	12-13	7-8
500	3,780	9,149	22,078	(852)	2,076	13-14	8-9
750	4,380	15,882	36,145	209	4,798	11-12	6-7
1000	5,370	19,869	45,107	346	6,062	10-11	6-7
1500	6,450	37,942	82,335	3,603	13,657	8-9	4-5

NOTES:

1. The 15% Price Differential of Amorphous Core Metal transformers over Silicon Steel transformers applies to mid-1990s projected prices based on current silicon steel transformer prices. This narrowing of the price gap will result with further advanced technology, productivity improvements in manufacturing processes, and economies-of-scale.

2. The 30% Price Differential of Amorphous Core Metal transformers over Silicon Steel transformers represents quantity discounts (marginal cost pricing or "price leverage") on at least 10 transformers with identical design and characteristics purchased in 1989.

3. Prices of transformers are subject to a high degree of volatility based on the world market price of copper (which has risen from nearly 60 cents per pound at the beginning of 1987 to $1.65 in December 1988), shifts in supply-demand for certain types of transformers than others, general inflation, and technology improvements. Since product life cycles are getting smaller than physical or economic life cycles resulting from constantly changing technology improvements, competetiveness in the marketplace has increased which favors consumers (buyers).

Exhibit 17

SAVINGS: AMORPHOUS METAL OVER CONVENTIONAL SILICON

(@ 15% Price Differential; Load Rating @ 90% Nameplate)

kVA	Price Differential ($)	Life Cycle Savings ($)		PV Savings ($)		Payback (Years)	
		6c/kwh	12c/kwh	6c/kwh	12c/kwh	6c/kwh	12c/kwh
25	98	747	1,591	94	285	6-7	3-4
75	345	2,202	4,749	232	809	7-8	4-5
150	930	5,068	11,065	428	1,787	8-9	4-5
300	1,575	9,337	20,249	896	3,368	8-9	4-5
500	1,890	10,277	22,443	865	3,621	8-9	4-5
750	2,190	17,857	37,905	2,350	6,890	6-7	3-4
1000	2,685	29,574	61,833	4,621	11,926	5-6	2-3
1500	3,225	74,822	152,869	14,450	32,125	2-3	1-2

(@ 30% Price Differential; Load Rating @ 90% Nameplate)

kVA	Price Differential ($)	Life Cycle Savings ($)		PV Savings ($)		Payback (Years)	
		6c/kwh	12c/kwh	6c/kwh	12c/kwh	6c/kwh	12c/kwh
25	195	649	1,494	(4)	187	11-12	6-7
75	690	1,857	4,404	(113)	464	13-14	7-8
150	1,860	4,138	10,135	(502)	857	14-15	8-9
300	3,150	7,762	18,674	(679)	1,793	13-14	8-9
500	3,780	8,387	20,553	(1025)	1,731	14-15	8-9
750	4,380	15,667	35,715	160	4,700	11-12	6-7
1000	5,370	26,889	59,148	1,936	9,241	9-10	5-6
1500	6,450	71,597	149,644	11,225	28,900	4-5	2-3

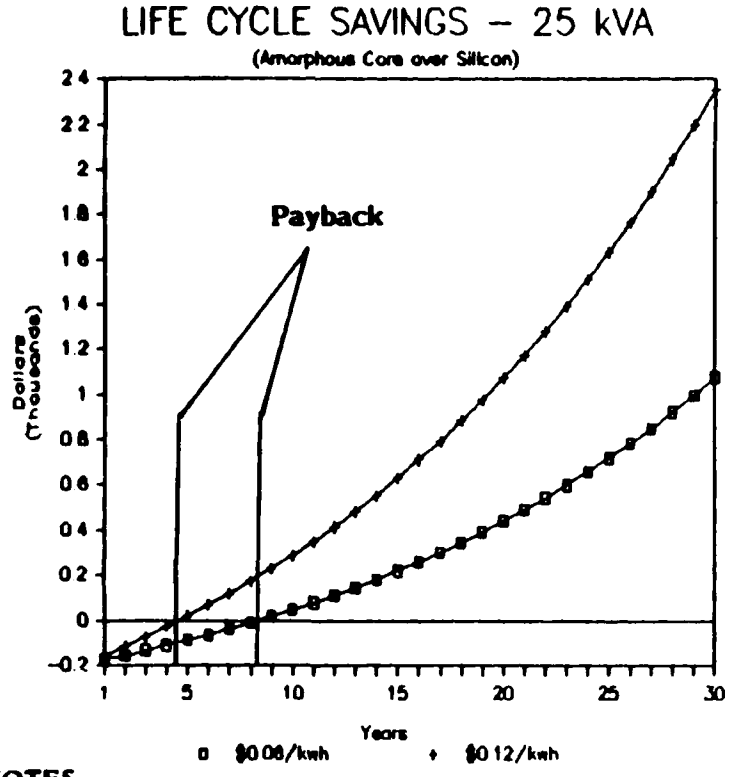
NOTES:

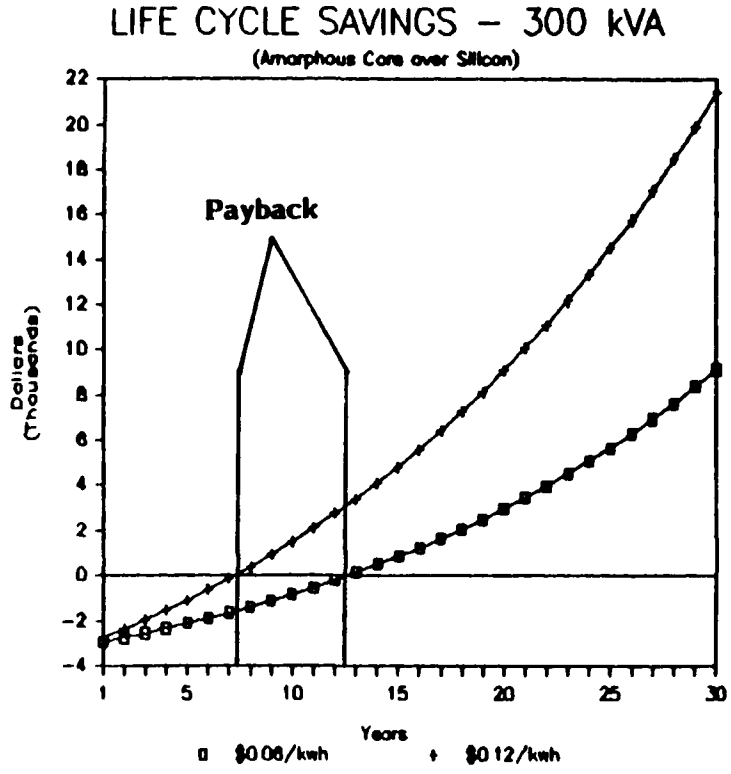
1. The 15% Price Differential of Amorphous Core Metal transformers over Silicon Steel transformers applies to mid-1990s projected prices based on current silicon steel transformer prices. This narrowing of the price gap will result with further advanced technology, productivity improvements in manufacturing processes, and economies-of-scale.

2. The 30% Price Differential of Amorphous Core Metal transformers over Silicon Steel transformers represents quantity discounts (marginal cost pricing or "price leverage") on at least 10 transformers with identical design and characteristics purchased in 1989.

3. Prices of transformers are subject to a high degree of volatility based on the world market price of copper (which has risen from nearly 60 cents per pound at the beginning of 1987 to $1.65 in December 1988), shifts in supply-demand for certain types of transformers than others, general inflation, and technology improvements. Since product life cycles are getting smaller than physical or economic life cycles resulting from constantly changing technology improvements, competetiveness in the marketplace has increased which favors consumers (buyers).

Exhibit 18



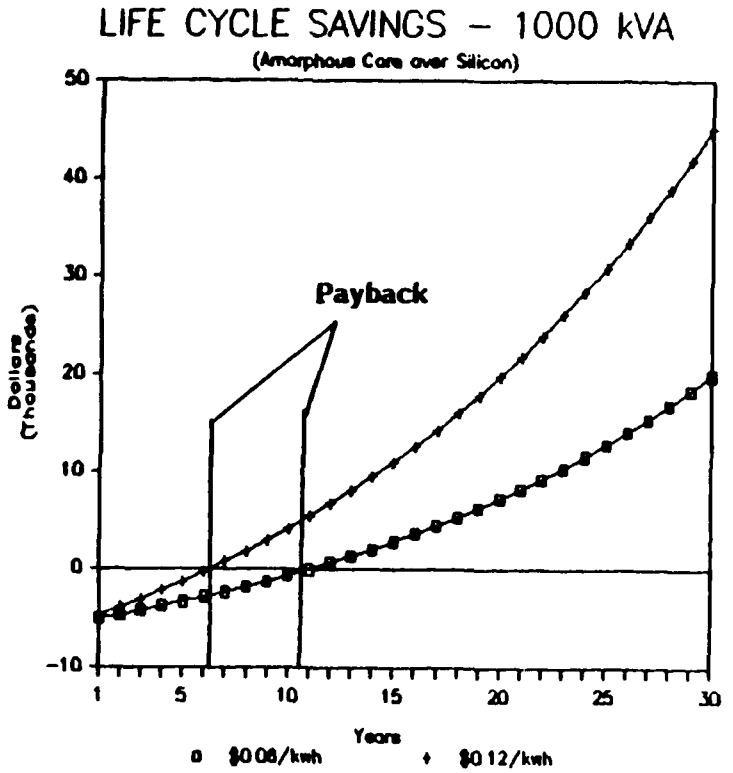


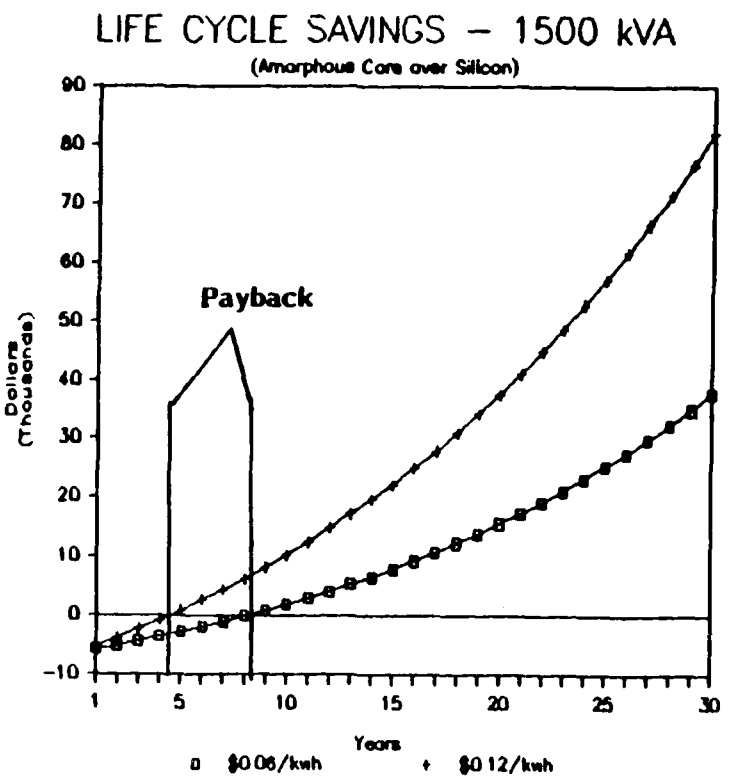
NOTES

1. Life Cycle Savings are shown (by the cumulative savings curves) for a 30% price differential of amorphous core transformers over corresponding mineral oil silicon steel transformers. The 30% price differential represents "quantity discount" prices for 10 or more identical transformers. The load rating is 50% of nameplate rating. Curves are shown for $0.06/kwh and $0.12/kwh.

2. The cumulative savings curves also show the payback periods. The payback is defined as the time needed to offset the price differential of a higher priced amorphous core transformer over a silicon steel transformer by the accrued energy savings resulting from lower losses, which are expected from an amorphous core transformer. As energy costs increase, so will be the savings, and the payback period gets shorter.

Exhibit 19





NOTES

1. Life Cycle Savings are shown (by the cumulative savings curves) for a 30% price differential of amorphous core transformers over corresponding mineral oil silicon steel transformers. The 30% price differential represents "quantity discount" prices for 10 or more identical transformers. The load rating is 50% of nameplate rating. Curves are shown for $0.06/kwh and $0.12/kwh.

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CONCLUSIONS

1. Liquid-filled transformers have lower life cycle costs than dry-types. This is to be expected since typically liquid-filled types have lower load losses than dry-types. Since both no-load and load loss costs are heavily dependent on energy costs ($/kwh), liquid-filled types will be cost competitive in a high cost energy environment.

2. Caution must be exercised when selecting liquid-filled transformers. While liquid-filled transformers typically demonstrate lower load losses, costs of transportation, installation, and maintenance are generally higher for liquid-filled transformers than for dry-types. Transportation, installation, and maintenance costs were not considered in this analysis because of unique but unknown site-specific needs and applications. The costs of installation and maintenance can vary widely according to the particular type of application and site requirements, regulatory compliance, and environmental constraints. Dry-type transformeres, though noisy and heavier, are robust, have fewer site and environmental restrictions, and require less maintenance. The relative electrical characteristics of liquid-filled and dry-type transformers also need to be evaluated. Cast coil transformers can be immediately switched on-and-off as required, thus greatly reducing no-load costs when they are not in use. This comparative advantage of the cast coil transformer can lead to lower life cycle cost, depending on the load duty cycle.

3. Economies-of-scale apply to amorphous core transformers with higher kVA ratings. The savings over a similar mineral oil transformer can be quite substantial. For example, a 1500 kVA amorphous core transformer with a 15% price differential over a similar silicon transformer can produce life cycle savings of nearly $75,000 with a payback period of 2-3 years for a 90% load rating. With "quantity discounts", there is at present a price differential of 30% for amorphous core over silicon transformers, which is expected to decrease to about 15% in the next 5 years or so.

4. Optimum kVA size and growth of load capacity need to be evaluated. These parameters were not considered in the analysis. Proper consideration of these factors depend on overall optimization of the distribution network system. Thus, a transformer with good overload capacity might be more suitable where future peak loads will be excessive.

5. A risk and uncertainty analysis is recommended as a next step because of the inherent uncertainties, both qualitative and quantitative, of key parameters. Decision-making in the context of dynamic changes in technology, shifts in policy and regulation, external influences, and an uncertain long-term economic and energy future, will at best be fuzzy. A risk analysis will help bring some of these issues into sharper focus.

REFERENCES

1. Westinghouse Distribution Systems Reference Book, Westinghouse Corp., 1959; Westinghouse Consulting Application Guide, Catalog 55-000 8th Edition 1986-1987.

2. PCB Transformer Changeout, Square D, Bulletin D-1M, 8/86.

3. Transformer Life Expectancy, S.C. Wick, Ph.D., Union Carbide Corp., 1987.

4. Distribution Transformer Loss Evaluation, D.L. Nickel; H.R. Braunstein, Westinghouse Electric Corp., 1980.

5. IEEE Conference Record 79CH1399-5-PWR(SUP), E.E. Gruchalla, 7th. IEEE/PS Transmission and Distribution Conference, 1979.

6. Transformer Cost of Ownership; Square D, Bulletin MOD-3, 2-86.

7. Transformer Testing, Square D, MOD-14, 6-87

8. Guide for Loading Power Transformers, W.E. Featheringill (Square D), IEEE Transactions on Industrial Applications; 1983.

9. Secondary Substation Transformer Selection Critical to Total System Planning, C.C. Rutledge (General Electric), Industrial Power Systems, 1984.

10. Transformer Economics, D.A. Duckett, General Electric Company, 1987.

11. Personal Communications, W.D. Nagel, General Electric Company, 1987-88.

12. Personal Communications, H.R. Braunstein, Westinghouse Corp. 1987-88.

13. A Method for Economic Evaluation of Distribution Transformers, Edison Electric Institute, 1981.

14. PCB Alternatives - An Update, K.R. Linsley, Westinghouse Corp.

15. Dry-Type Transformers in the United States, L.O. Kaser, Du Pont, 1982.

APPENDIX
(Spreadsheets)

SUMMARY OF KEY FACTS AND ASSUMPTIONS

1. Purchase prices of transformers are end-of-year 1988 estimates. Prices of Mineral oil, Silicone, RTEmp, and Amorphous core transformers are based on "quantity discounts". Discounts apply to at least 10 identical transformers purchased at the same time. The purchase prices used in the analysis for the above-mentioned transformers are the discounted prices. There is a 30% price differential of Amorphous core transformers over Mineral oil transformers. This price differential is expected to decrease to about 15% in the next 5 years or so.
2. Prices are subject to variation depending on design and technology improvements, manufacturing productivity, changes in material and labor costs, general inflation, economies-of-scale, product life cycles, and on supply-demand changes for transformers at the time of purchase.
3. The discount (nominal) rate used is 10% (OMB Circular No. A-76). "Cash flows" or cost outlays spread over future years are discounted at this fixed rate to provide a single value at the beginning called the "Present Value (PV)". The Present Value summarizes the economic value of the costs and benefits spread over time, of a project, product, or service, as the case may be. It also makes comparison of alternatives easier and more meaningful.
4. Energy cost escalator is assumed to be 5% compounded annually. This rate is also assumed to be the inflation rate. In other words, energy cost growth keeps pace only with general price inflation, without any effects from real supply-demand changes in electric production and consumption.
5. Criteria used in the analysis are: Life Cycle Costs (or Costs of Ownership), Present Value, and Payback.
6. Transformer Operating Life is assumed to be 30 years, operating for 8760 hours for each year.
7. Load Rating (LR) is the load on the transformer as a percent of nameplate rating. An average of 50% is assumed in the analysis. For the sensitivity analysis of amorphous core over mineral oil (silicon core) transformers, load ratings of 10%, 50%, and 90% were used.
8. The only costs included in the analysis are: Purchase cost, no-load and load loss operating costs. Transportation and installation costs are heavily dependent on location and site specifics. A rough estimate of $200 can be assumed for installation per transformer. If actual transportation, handling, and installation costs are known, these costs can be simply added to the already computed life cycle costs. Maintenance costs are zero or negligible for distribution transformers. If a maintenance program is already in-place, a pro-rated cost can be applied if necessary.
9. All cash flows (cost outlays) are assumed to occur at the end of each year, except that purchase cost is incurred at the beginning of the first year at time zero.
10. All load and no-load losses are typical and not guaranteed losses at standard HV/LV ratings (eg. 13,800V-HV, 480Y/277V-LV), percent impedance (eg. 4.4), reference temperature (eg. 65°C rise), and standard (not low loss) design.
11. Failure, breakdown, repair, accident, or any other event causing downtime is not incorporated in the analysis.
12. 25 kVA rated transformers are single-phase; all others are three-phase.

NOMENCLATURE

EC: Energy Cost ($/kwh; $0.06/kwh for Norfolk)
NLL: No-Load Loss (kw)
LL: Load Loss (kw)
LR: Load Rating %
(defined here as: [Operating Load(kVA)/Nameplate Rating(kVA)]*100)

NLAC: No-Load Annual Cost ($)
LLAC: Load Loss Annual Cost ($)
TAC: Total Annual Cost ($)
CUMTAC: Cumulative Total Annual Cost
CUMNLAC: Cumulative No-Load Annual Cost
CUMLLAC: Cumulative Load Loss Annual Cost

PP: Purchase Price ($)
LCC: Life Cycle Cost
LCS: Life Cycle Savings ($)
PV: Present Value ($)

SPREADSHEET LINE ITEM	EXPLANATION
1. States Transformer type (eg. Amorphous core - 25 kva) and purchase price	---
2. Item heading and ten year span heading(s)	Since the project life cycle is 30 years, the spreadsheet is comprised of 3 decade cycles, with repetitive line items.
3. Energy cost ($/kwh)	The energy cost is assumed to be $0.06 kwh for the first year and grows at 5% compound rate for 29 years.
4. NoLoadLoss (LL-kw)	This is the rough estimate of no-load loss for the transformer which is subject to variation

because of different manufactuer designs and production processes, particular application of the transformer, and time estimate was made.

5. LoadRating (LR-%)

Defined here as the ratio of the average operating load to the nameplate rating. For Norfolk, a 50% load factor is the average, although a low of 10% and a high of 75% are not unrepresentative. The load factor of 50% is used for each year in the computations of load loss cost.

6. NoLoadAnnualCost (NLAC)

No-load annual cost is independent of load; it is the product of no-load (core)loss, unit energy cost and 8760, the number of hours in a year (assuming core is energized at all times).

7. LoadLossAnnualCost (LLAC)

Cost incurred due to load (winding or I^2R) losses; it is the product of energy cost, the rated load losses at full kVA rating, the load factor squared, and 8760, the total number of hours in each year.

8 TotalAnnualCost (TAC)

This is simply the annual operating cost, and is the sum of no-load annual cost and load loss annual cost.

9. CUMTAC

It is the cumulative total annual cost, obtained by successively adding the prior total annual costs upto and including the

	year of interest.
10. CUMNLAC	This is the cumulative no-load annual cost, and is the sum of the no-load annual costs of all years prior to and including the year of interest.
11. CUMLLAC	It is the cumulative load loss annual cost, and is the sum of the load loss annual costs of all years prior to and including the year of interest
12. Life Cycle Cost	This is the sum of the purchase price, the no-load loss cost, and the load loss cost; the total no-load loss cost for the life cycle is the CUMNLAC for year 30; CUMLLAC for year 30 is the total load loss cost for the life cycle.
13. PV	Present Value; the discount rate used is 10%.

CASE: OIL - 25 KVA PURCHASE PRICE: $650

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.088	0.092
NoLoadLoss (NLL-kw)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
LoadLoss (LL-kw)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	31.54	33.11	34.77	36.51	38.33	40.25	42.26	44.37	46.59	48.92
LoadLossAnnualCost (LLAC)	28.91	30.35	31.87	33.46	35.14	36.89	38.74	40.68	42.71	44.85
TotalAnnualCost (TAC)	60.44	63.47	66.64	69.97	73.47	77.14	81.00	85.05	89.30	93.77
CUMTAC	60.44	127.91	190.55	260.52	333.99	411.13	492.14	577.19	666.49	760.26
CUMNLAC	31.54	64.65	99.42	135.92	174.26	214.51	256.77	301.14	347.73	396.65
CUMLLAC	28.91	59.26	91.13	124.60	159.73	196.63	235.37	276.05	318.76	363.61

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
LoadLoss (LL-kw)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	51.37	53.94	56.63	59.47	62.44	65.56	68.84	72.28	75.90	79.69
LoadLossAnnualCost (LLAC)	47.09	49.44	51.91	54.51	57.24	60.10	63.10	66.26	69.57	73.05
TotalAnnualCost (TAC)	98.46	103.38	108.55	113.98	119.67	125.66	131.94	138.54	145.47	152.74
CUMTAC	858.72	962.09	1070.64	1184.62	1304.29	1429.95	1561.90	1700.43	1845.90	1998.64
CUMNLAC	448.03	501.96	558.60	618.06	680.50	746.06	814.90	887.18	963.08	1042.77
CUMLLAC	410.69	460.13	512.05	566.56	623.74	683.89	746.99	813.25	882.82	955.87

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
LoadLoss (LL-kw)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	83.67	87.86	92.25	96.86	101.71	106.79	112.13	117.74	123.63	129.81
LoadLossAnnualCost (LLAC)	76.70	80.54	84.56	88.79	93.23	97.89	102.79	107.93	113.32	118.99
TotalAnnualCost (TAC)	160.38	168.39	176.81	185.66	194.94	204.68	214.92	225.67	236.95	248.80
CUMTAC	2159.01	2327.41	2504.22	2689.88	2884.82	3089.50	3304.42	3530.09	3767.03	4015.83
CUMNLAC	1126.44	1214.30	1306.55	1403.42	1505.12	1611.91	1724.05	1841.78	1965.41	2095.22
CUMLLAC	1032.57	1113.11	1197.67	1286.46	1379.69	1477.59	1580.38	1688.30	1801.62	1920.61

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$4,666	= $650	$2,095	$1,921
PV	PV	PV	PV
$1,559	$650	$475	$435

CASE: OIL - 75 KVA PURCHASE PRICE: $2,300

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131
LoadLoss (LL-kw)	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	51
NoLoadAnnualCost (NLAC)	68.85	72.30	75.91	79.71	83.69	87.88	92.27	96.88	101.72	106.81
LoadLossAnnualCost (LLAC)	80.02	84.02	88.22	92.64	97.27	102.13	107.24	112.60	118.23	124.14
TotalAnnualCost (TAC)	148.88	156.32	164.14	172.34	180.96	190.01	199.51	209.49	219.96	230.95
CUMTAC	148.88	305.20	469.33	641.68	822.63	1012.64	1212.15	1421.64	1641.59	1872.55
CUMNLAC	68.85	141.15	217.06	296.77	380.46	468.34	560.61	657.49	759.22	866.03
CUMLLAC	80.02	164.05	252.27	344.91	442.18	544.31	651.54	764.14	882.37	1006.51

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131
LoadLoss (LL-kw)	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	51
NoLoadAnnualCost (NLAC)	112.16	117.76	123.65	129.83	136.33	143.14	150.30	157.81	165.70	173.98
LoadLossAnnualCost (LLAC)	130.35	136.87	143.71	150.89	158.44	166.36	174.68	183.41	192.58	202.21
TotalAnnualCost (TAC)	242.50	254.63	267.36	280.73	294.76	309.50	324.98	341.22	358.29	376.21
CUMTAC	2115.05	2369.68	2637.04	2917.77	3212.53	3522.04	3847.02	4188.24	4546.53	4922.73
CUMNLAC	978.19	1095.95	1219.60	1349.44	1485.76	1628.90	1779.20	1937.02	2102.72	2276.71
CUMLLAC	1136.86	1273.73	1417.44	1568.33	1726.77	1893.13	2067.81	2251.23	2443.81	2645.02

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131
LoadLoss (LL-kw)	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609	0.609
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	182.69	191.82	201.41	211.49	222.06	233.16	244.82	257.06	269.92	283.41
LoadLossAnnualCost (LLAC)	212.32	222.94	234.09	245.79	258.08	270.98	284.53	298.76	313.70	329.38
TotalAnnualCost (TAC)	395.01	414.76	435.50	457.28	480.14	504.15	529.36	555.82	583.61	612.79
CUMTAC	5317.75	5732.51	6168.01	6625.29	7105.43	7609.58	8138.93	8694.75	9278.37	9891.16
CUMNLAC	2459.40	2651.22	2852.64	3064.12	3286.18	3519.35	3764.17	4021.23	4291.14	4574.55
CUMLLAC	2858.35	3081.29	3315.37	3561.17	3819.25	4090.23	4374.77	4673.53	4987.23	5316.61

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$12,191	=	$2,300	$4,575	$5,317
PV		PV	PV	PV
$4,540		$2,300	$1,036	$1,204

CASE: OIL - 150 KVA PURCHASE PRICE: $6,200

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	0.291	0.291	0.291	0.291	0.291	0.291	0.291	0.291	0.291	0.291
LoadLoss (LL-kw)	1.097	1.097	1.097	1.097	1.097	1.097	1.097	1.097	1.097	1.097
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	152.95	160.60	168.63	177.06	185.91	195.21	204.97	215.22	225.98	237.28
LoadLossAnnualCost (LLAC)	144.15	151.35	158.92	166.87	175.21	183.97	193.17	202.83	212.97	223.62
TotalAnnualCost (TAC)	297.10	311.95	327.55	343.93	361.12	379.18	398.14	418.04	438.95	460.89
CUMTAC	297.10	609.05	936.59	1280.52	1641.64	2020.82	2418.95	2837.00	3275.94	3736.83
CUMNLAC	152.95	313.55	482.17	659.23	845.14	1040.35	1245.32	1460.53	1686.51	1923.78
CUMLLAC	144.15	295.50	454.42	621.29	796.50	980.47	1173.64	1376.46	1589.43	1813.05

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	0.291	0.291	0.291	0.291	0.291	0.291	0.291	0.291	0.291	0.291
LoadLoss (LL-kw)	1.097	1.097	1.097	1.097	1.097	1.097	1.097	1.097	1.097	1.097
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	249.14	261.60	274.68	288.41	302.83	317.97	333.87	350.56	368.09	386.50
LoadLossAnnualCost (LLAC)	234.80	246.54	258.87	271.81	285.40	299.67	314.65	330.38	346.90	364.25
TotalAnnualCost (TAC)	483.94	508.13	533.54	560.22	588.23	617.64	648.52	680.95	715.00	750.75
CUMTAC	4220.77	4728.91	5262.45	5822.66	6410.89	7028.53	7677.05	8358.00	9073.00	9823.74
CUMNLAC	2172.92	2434.52	2709.19	2997.60	3300.43	3618.40	3952.27	4302.84	4670.93	5057.43
CUMLLAC	2047.85	2294.39	2553.25	2825.06	3110.46	3410.13	3724.78	4055.17	4402.07	4766.32

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.291	0.291	0.291	0.291	0.291	0.291	0.291	0.291	0.291	0.291
LoadLoss (LL-kw)	1.097	1.097	1.097	1.097	1.097	1.097	1.097	1.097	1.097	1.097
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	405.82	426.11	447.42	469.79	493.28	517.94	543.84	571.03	599.58	629.56
LoadLossAnnualCost (LLAC)	382.46	401.58	421.66	442.75	464.88	488.13	512.54	538.16	565.07	593.32
TotalAnnualCost (TAC)	788.28	827.70	869.08	912.54	958.16	1006.07	1056.37	1109.19	1164.65	1222.88
CUMTAC	10612.03	11439.72	12308.80	13221.34	14179.50	15185.57	16241.95	17351.14	18515.79	19738.68
CUMNLAC	5463.25	5889.36	6336.77	6806.56	7299.84	7817.78	8361.62	8932.65	9532.23	10161.80
CUMLLAC	5148.78	5550.36	5972.03	6414.78	6879.66	7367.79	7880.32	8418.49	8983.56	9576.88

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$25,939	= $6,200	$10,162	$9,577
PV	PV	PV	PV
$10,670	$6,200	$2,301	$2,169

CASE: OIL - 300 KVA PURCHASE PRICE: $10,500

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.088	0.092
NoLoadLoss (NLL-kw)	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535
LoadLoss (LL-kw)	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	281.20	295.26	310.02	325.52	341.80	358.89	376.83	395.67	415.45	436.22
LoadLossAnnualCost (LLAC)	234.68	246.41	258.74	271.67	285.26	299.52	314.49	330.22	346.73	364.07
TotalAnnualCost (TAC)	515.88	541.67	568.75	597.19	627.05	658.40	691.32	725.89	762.19	800.29
CUMTAC	515.88	1057.55	1626.30	2223.49	2850.54	3508.95	4200.27	4926.16	5688.34	6488.64
CUMNLAC	281.20	576.45	886.47	1211.99	1553.79	1912.67	2289.50	2685.17	3100.63	3536.85
CUMLLAC	234.68	481.09	739.83	1011.50	1296.76	1596.28	1910.77	2240.99	2587.72	2951.79

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535
LoadLoss (LL-kw)	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	458.04	480.94	504.99	530.24	556.75	584.59	613.82	644.51	676.73	710.57
LoadLossAnnualCost (LLAC)	382.27	401.38	421.45	442.52	464.65	487.88	512.28	537.89	564.79	593.03
TotalAnnualCost (TAC)	840.31	882.32	926.44	972.76	1021.40	1072.47	1126.09	1182.40	1241.52	1303.59
CUMTAC	7328.95	8211.27	9137.71	10110.47	11131.87	12204.34	13330.44	14512.83	15754.35	17057.95
CUMNLAC	3994.89	4475.83	4980.82	5511.06	6067.81	6652.39	7266.21	7910.71	8587.45	9298.01
CUMLLAC	3334.05	3735.44	4156.89	4599.41	5064.07	5551.95	6064.23	6602.12	7166.91	7759.93

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535	0.535
LoadLoss (LL-kw)	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	746.10	783.40	822.57	863.70	906.89	952.23	999.84	1049.83	1102.32	1157.44
LoadLossAnnualCost (LLAC)	622.68	653.81	686.50	720.83	756.87	794.71	834.45	876.17	919.98	965.98
TotalAnnualCost (TAC)	1368.77	1437.21	1509.07	1584.53	1663.75	1746.94	1834.29	1926.00	2022.30	2123.42
CUMTAC	18426.72	19863.93	21373.00	22957.53	24621.28	26368.22	28202.51	30128.51	32150.82	34274.23
CUMNLAC	10044.11	10827.51	11650.08	12513.78	13420.67	14372.90	15372.74	16422.57	17524.90	18682.34
CUMLLAC	8382.61	9036.42	9722.92	10443.75	11200.61	11995.33	12829.77	13705.94	14625.92	15591.90

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$44,774	=	$10,500	$18,682	$15,592
PV		PV	PV	PV
$18,262		$10,500	$4,231	$3,531

CASE: OIL - 500 KVA PURCHASE PRICE: $12,600

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.09[illegible]
NoLoadLoss (NLL-kw)	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
LoadLoss (LL-kw)	3.153	3.153	3.153	3.153	3.153	3.153	3.153	3.153	3.153	3.153
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	5[illegible]
NoLoadAnnualCost (NLAC)	320.62	336.65	353.48	371.15	389.71	409.20	429.66	451.14	473.70	497.38
LoadLossAnnualCost (LLAC)	414.30	435.02	456.77	479.61	503.59	528.77	555.21	582.97	612.12	642.72
TotalAnnualCost (TAC)	734.92	771.67	810.25	850.76	893.30	937.97	984.86	1034.11	1085.81	1140.1[illegible]
CUMTAC	734.92	1506.59	2316.84	3167.60	4060.90	4998.86	5983.73	7017.83	8103.64	9243.75
CUMNLAC	320.62	657.26	1010.74	1381.90	1771.61	2180.80	2610.46	3061.60	3535.29	4[illegible]
CUMLLAC	414.30	849.32	1306.09	1785.70	2289.29	2818.06	3373.27	3956.24	4568.35	5211.[illegible]

ITEM	YEAR 11	12	13	14	15	16	17	18	19	2[illegible]
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.15[illegible]
NoLoadLoss (NLL-kw)	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
LoadLoss (LL-kw)	3.153	3.153	3.153	3.153	3.153	3.153	3.153	3.153	3.153	3.153
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	5[illegible]
NoLoadAnnualCost (NLAC)	522.25	548.36	575.78	604.57	634.80	666.54	699.86	734.86	771.60	810.18
LoadLossAnnualCost (LLAC)	674.86	708.60	744.03	781.23	820.29	861.31	904.37	949.59	997.07	1046.9[illegible]
TotalAnnualCost (TAC)	1197.11	1256.96	1319.81	1385.80	1455.09	1527.85	1604.24	1684.45	1768.67	1857.11
CUMTAC	10440.85	11697.82	13017.63	14403.43	15859.52	17386.37	18990.61	20675.06	22443.73	24[illegible]
CUMNLAC	4554.92	5103.29	5679.07	6283.63	6918.43	7584.97	8284.83	9019.69	9791.29	10[illegible]
CUMLLAC	5885.93	6594.53	7338.56	8119.80	8940.09	9801.40	10705.77	11655.37	12652.44	136[illegible]

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
LoadLoss (LL-kw)	3.153	3.153	3.153	3.153	3.153	3.153	3.153	3.153	3.153	3.153
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	850.69	893.22	937.89	984.78	1034.02	1085.72	1140.01	1197.01	1256.86	1319.70
LoadLossAnnualCost (LLAC)	1099.27	1154.24	1211.95	1272.55	1336.17	1402.98	1473.13	1546.79	1624.13	1705.3[illegible]
TotalAnnualCost (TAC)	1949.96	2047.46	2149.83	2257.32	2370.19	2488.70	2613.14	2743.79	2880.99	3025.0[illegible]
CUMTAC	26250.80	28298.26	30448.09	32705.42	35075.61	37564.31	40177.45	42921.24	45802.22	48827.[illegible]
CUMNLAC	11452.16	12345.39	13283.27	14268.05	15302.07	16387.79	17527.80	18724.80	19981.66	21301.3[illegible]
CUMLLAC	14798.64	15952.87	17164.82	18437.37	19773.54	21176.52	22649.65	24196.44	25820.56	27525.[illegible]

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$61,427	=	$12,600	$21,301	$27,526
PV		PV	PV	PV
$23,658		$12,600	$4,824	$6,234

CASE: OIL - 750 KVA PURCHASE PRICE: $14,600

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897
LoadLoss (LL-kw)	4.388	4.388	4.388	4.388	4.388	4.388	4.388	4.388	4.388	4.388
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	471.46	495.04	519.79	545.78	573.07	601.72	631.81	663.40	696.57	731.39
LoadLossAnnualCost (LLAC)	576.58	605.41	635.68	667.47	700.84	735.88	772.68	811.31	851.88	894.47
TotalAnnualCost (TAC)	1048.05	1100.45	1155.47	1213.24	1273.91	1337.60	1404.48	1474.71	1548.44	1625.86
CUMTAC	1048.05	2148.50	3303.97	4517.21	5791.12	7128.72	8533.20	10007.91	11556.35	13182.21
CUMNLAC	471.46	966.50	1486.29	2032.07	2605.13	3206.85	3838.66	4502.05	5198.62	5929.01
CUMLLAC	576.58	1182.00	1817.68	2485.15	3185.99	3921.87	4694.55	5505.86	6357.73	7252.20

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897
LoadLoss (LL-kw)	4.388	4.388	4.388	4.388	4.388	4.388	4.388	4.388	4.388	4.388
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	767.96	806.36	846.68	889.01	933.46	980.14	1029.15	1080.60	1134.63	1191.36
LoadLossAnnualCost (LLAC)	939.19	986.15	1035.46	1087.23	1141.60	1198.68	1258.61	1321.54	1387.62	1457.00
TotalAnnualCost (TAC)	1707.16	1792.52	1882.14	1976.25	2075.06	2178.81	2287.75	2402.14	2522.25	2648.36
CUMTAC	14889.37	16681.89	18564.03	20540.28	22615.34	24794.15	27081.90	29484.04	32006.29	34654.65
CUMNLAC	6697.98	7504.34	8351.02	9240.03	10173.50	11153.64	12182.78	13263.38	14398.02	15589.38
CUMLLAC	8191.39	9177.55	10213.01	11300.24	12441.84	13640.51	14899.12	16220.66	17608.28	19065.27

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897
LoadLoss (LL-kw)	4.388	4.388	4.388	4.388	4.388	4.388	4.388	4.388	4.388	4.388
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1250.93	1313.48	1379.15	1448.11	1520.52	1596.54	1676.37	1760.19	1848.20	1940.61
LoadLossAnnualCost (LLAC)	1529.85	1606.34	1686.66	1770.99	1859.54	1952.52	2050.14	2152.65	2260.28	2373.29
TotalAnnualCost (TAC)	2780.78	2919.82	3065.81	3219.10	3380.05	3549.06	3726.51	3912.84	4108.46	4313.90
CUMTAC	37435.43	40355.25	43421.06	46640.16	50020.21	53569.27	57295.78	61208.62	65317.09	69630.99
CUMNLAC	16840.31	18153.79	19532.94	20981.05	22501.57	24098.11	25774.48	27534.67	29382.87	31323.47
CUMLLAC	20595.12	22201.46	23888.12	25659.10	27518.64	29471.16	31521.30	33673.95	35934.23	38307.52

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$84,231	=	$14,600	$31,323	$38,308
PV		PV	PV	PV
$30,369		$14,600	$7,094	$8,675

CASE: OIL - 1000 KVA PURCHASE PRICE: $17,900

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033
LoadLoss (LL-kw)	5.843	5.843	5.843	5.843	5.843	5.843	5.843	5.843	5.843	5.843
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	542.94	570.09	598.60	628.53	659.95	692.95	727.60	763.98	802.18	842.29
LoadLossAnnualCost (LLAC)	767.77	806.16	846.47	888.79	933.23	979.89	1028.89	1080.33	1134.35	1191.06
TotalAnnualCost (TAC)	1310.72	1376.25	1445.06	1517.32	1593.18	1672.84	1756.48	1844.31	1936.52	2033.35
CUMTAC	1310.72	2686.97	4132.03	5649.35	7242.53	8915.37	10671.85	12516.16	14452.68	16486.03
CUMNLAC	542.94	1113.04	1711.63	2340.16	3000.11	3693.06	4420.66	5184.64	5986.82	6829.10
CUMLLAC	767.77	1573.93	2420.40	3309.19	4242.42	5222.31	6251.19	7331.52	8465.87	9656.93

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033
LoadLoss (LL-kw)	5.843	5.843	5.843	5.843	5.843	5.843	5.843	5.843	5.843	5.843
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	884.40	928.62	975.05	1023.80	1074.99	1128.74	1185.18	1244.44	1306.66	1371.99
LoadLossAnnualCost (LLAC)	1250.62	1313.15	1378.80	1447.75	1520.13	1596.14	1675.95	1759.74	1847.73	1940.12
TotalAnnualCost (TAC)	2135.02	2241.77	2353.86	2471.55	2595.13	2724.88	2861.13	3004.18	3154.39	3312.11
CUMTAC	18621.05	20862.82	23216.67	25688.22	28283.35	31008.23	33869.36	36873.54	40027.93	43340.04
CUMNLAC	7713.50	8642.12	9617.17	10640.98	11715.97	12844.71	14029.89	15274.33	16580.99	17952.99
CUMLLAC	10907.55	12220.70	13599.50	15047.25	16567.38	18163.52	19839.46	21599.21	23446.94	25387.05

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033
LoadLoss (LL-kw)	5.843	5.843	5.843	5.843	5.843	5.843	5.843	5.843	5.843	5.843
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1440.59	1512.62	1588.26	1667.67	1751.05	1838.60	1930.53	2027.06	2128.41	2234.83
LoadLossAnnualCost (LLAC)	2037.12	2138.98	2245.93	2358.22	2476.14	2599.94	2729.94	2866.44	3009.76	3160.25
TotalAnnualCost (TAC)	3477.72	3651.60	3834.18	4025.89	4227.19	4438.55	4660.47	4893.50	5138.17	5395.09
CUMTAC	46817.76	50469.36	54303.55	58329.44	62556.62	66995.17	71655.64	76549.14	81687.31	87082.39
CUMNLAC	19393.58	20906.21	22494.46	24162.13	25913.18	27751.78	29682.32	31709.38	33837.79	36072.63
CUMLLAC	27424.18	29563.16	31809.08	34167.31	36643.44	39243.39	41973.33	44839.76	47849.52	51009.77

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$104,982	= $17,900	$36,073	$51,010
PV	PV	PV	PV
$37,621	$17,900	$8,169	$11,552

CASE: OIL - 1500 KVA PURCHASE PRICE: $21,500

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	1.409	1.409	1.409	1.409	1.409	1.409	1.409	1.409	1.409	1.409
LoadLoss (LL-kw)	8.934	8.934	8.934	8.934	8.934	8.934	8.934	8.934	8.934	8.934
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	51
NoLoadAnnualCost (NLAC)	740.57	777.60	816.48	857.30	900.17	945.18	992.44	1042.06	1094.16	1148.87
LoadLossAnnualCost (LLAC)	1173.93	1232.62	1294.26	1358.97	1426.92	1498.26	1573.19	1651.83	1734.43	1821.15
TotalAnnualCost (TAC)	1914.50	2010.22	2110.73	2216.27	2327.08	2443.44	2565.61	2693.89	2828.59	2971.01
CUMTAC	1914.50	3924.72	6035.45	8251.73	10578.81	13022.25	15587.86	18281.75	21110.34	24081.35
CUMNLAC	740.57	1518.17	2334.65	3191.95	4092.12	5037.30	6029.73	7071.79	8165.95	9314.81
CUMLLAC	1173.93	2406.55	3700.81	5059.77	6486.69	7984.95	9558.13	11209.96	12944.39	14765.54

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	1.409	1.409	1.409	1.409	1.409	1.409	1.409	1.409	1.409	1.409
LoadLoss (LL-kw)	8.934	8.934	8.934	8.934	8.934	8.934	8.934	8.934	8.934	8.934
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	51
NoLoadAnnualCost (NLAC)	1206.31	1266.63	1329.96	1396.46	1466.28	1539.59	1616.57	1697.40	1782.27	1871.38
LoadLossAnnualCost (LLAC)	1912.20	2007.81	2108.21	2213.62	2324.30	2440.51	2562.54	2690.66	2825.21	2966.47
TotalAnnualCost (TAC)	3118.52	3274.44	3438.16	3610.07	3790.58	3980.10	4179.11	4388.06	4607.47	4837.84
CUMTAC	27198.87	30473.31	33911.47	37521.54	41312.12	45292.22	49471.33	53859.39	58466.86	63304.70
CUMNLAC	10521.13	11787.75	13117.71	14514.17	15980.45	17520.04	19136.61	20834.01	22616.28	24487.67
CUMLLAC	16677 74	18685.55	20793.76	23007.38	25331.67	27772.18	30334.72	33025.38	35850.58	38817.04

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	1.409	1.409	1.409	1.409	1.409	1.409	1.409	1.409	1.409	1.409
LoadLoss (LL-kw)	8.934	8.934	8.934	8.934	8.934	8.934	8.934	8.934	8.934	8.934
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1964.95	2063.20	2166.36	2274.68	2388.41	2507.83	2633.23	2764.89	2903.13	3048.29
LoadLossAnnualCost (LLAC)	3114.78	3270.52	3434.04	3605.75	3786.03	3975.34	4174.10	4382.81	4601.95	4832.05
TotalAnnualCost (TAC)	5079.73	5333.72	5600.41	5880.43	6174.45	6483.17	6807.33	7147.69	7505.08	7880.33
CUMTAC	68384.44	73718.16	79318.56	85198.99	91373.44	97856.60	104663.93	111811.63	119316.71	127197.04
CUMNLAC	26452.62	28515.82	30682.18	32956.86	35345.28	37853.11	40486.34	43251.22	46154.36	49202.64
CUMLLAC	41931.82	45202.35	48636.38	52242.12	56028.16	60003.49	64177.60	68560.40	73162.35	77994.40

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$148,697	= $21,500	$49,203	$77,994
PV	PV	PV	PV
$50,306	$21,500	$11,143	$17,663

CASE: AMORPHOUS CORE - 25 KVA PURCHASE PRICE: $800

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.088	0.092
NoLoadLoss (NLL-kw)	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
LoadLoss (LL-kw)	0.242	0.242	0.242	0.242	0.242	0.242	0.242	0.242	0.242	0.242
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	5
NoLoadAnnualCost (NLAC)	9.46	9.93	10.43	10.95	11.50	12.07	12.68	13.31	13.98	14.68
LoadLossAnnualCost (LLAC)	31.80	33.39	35.06	36.81	38.65	40.58	42.61	44.74	46.98	49.33
TotalAnnualCost (TAC)	41.26	43.32	45.49	47.76	50.15	52.66	55.29	58.06	60.96	64.01
CUMTAC	41.26	84.58	130.07	177.83	227.99	280.64	335.94	393.99	454.95	518.96
CUMNLAC	9.46	19.39	29.83	40.78	52.28	64.35	77.03	90.34	104.32	119.00
CUMLLAC	31.80	65.19	100.25	137.06	175.71	216.29	258.91	303.65	350.63	399.96

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
LoadLoss (LL-kw)	0.242	0.242	0.242	0.242	0.242	0.242	0.242	0.242	0.242	0.242
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	5
NoLoadAnnualCost (NLAC)	15.41	16.18	16.99	17.84	18.73	19.67	20.65	21.68	22.77	23.91
LoadLossAnnualCost (LLAC)	51.80	54.39	57.11	59.96	62.96	66.11	69.41	72.88	76.53	80.35
TotalAnnualCost (TAC)	67.21	70.57	74.10	77.80	81.69	85.78	90.06	94.57	99.30	104.26
CUMTAC	586.1663	656.7342	730.8305	808.6317	890.3229	976.0986	1066.163	1160.730	1260.027	1364.288
CUMNLAC	134.4075	150.5887	167.5789	185.4187	204.1504	223.8187	244.4705	266.1548	288.9324	312.8332
CUMLLAC	451.7587	506.1455	563.2515	623.2129	686.1724	752.2798	821.6926	894.5760	971.1036	1051.457

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
LoadLoss (LL-kw)	0.242	0.242	0.242	0.242	0.242	0.242	0.242	0.242	0.242	0.242
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	25.10	26.36	27.68	29.06	30.51	32.04	33.64	35.32	37.09	38.94
LoadLossAnnualCost (LLAC)	84.37	88.59	93.02	97.67	102.55	107.68	113.07	118.72	124.66	130.89
TotalAnnualCost (TAC)	109.4740	114.9477	120.6950	126.7298	133.0663	139.7196	146.7056	154.0409	161.7429	169.8301
CUMTAC	1473.762	1588.709	1709.404	1836.134	1969.201	2108.920	2255.626	2409.667	2571.410	2741.240
CUMNLAC	337.9326	364.2901	391.9654	421.0245	451.5365	483.5741	517.2136	552.5351	589.6227	628.5546
CUMLLAC	1135.829	1224.419	1317.439	1415.110	1517.664	1625.346	1738.412	1857.132	1981.787	2112.675

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$3,541	=	$800	$629	$2,113
PV		PV	PV	PV
$1,421		$800	$142	$478

CASE: AMORPHOUS CORE - 75 KVA PURCHASE PRICE: $2,990

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.088	0.092
NoLoadLoss (NLL-kw)	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037
LoadLoss (LL-kw)	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	19.45	20.42	21.44	22.51	23.64	24.82	26.06	27.36	28.73	30.17
LoadLossAnnualCost (LLAC)	83.44	87.61	91.99	96.59	101.42	106.49	111.82	117.41	123.28	129.44
TotalAnnualCost (TAC)	102.89	108.03	113.43	119.10	125.06	131.31	137.88	144.77	152.01	159.61
CUMTAC	102.89	210.92	324.35	443.45	568.51	699.82	837.70	982.47	1134.48	1294.09
CUMNLAC	19.45	39.87	61.31	83.82	107.46	132.28	158.34	185.70	214.44	244.60
CUMLLAC	83.44	171.05	263.04	359.63	461.05	567.54	679.36	796.77	920.05	1049.49

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037
LoadLoss (LL-kw)	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	31.68	33.26	34.92	36.67	38.50	40.43	42.45	44.57	46.80	49.14
LoadLossAnnualCost (LLAC)	135.91	142.71	149.84	157.34	165.20	173.46	182.14	191.24	200.81	210.85
TotalAnnualCost (TAC)	167.59	175.97	184.77	194.01	203.71	213.89	224.59	235.82	247.61	259.99
CUMTAC	1461.682	1637.652	1822.421	2016.428	2220.136	2434.029	2658.617	2894.434	3142.042	3402.030
CUMNLAC	276.2822	309.5435	344.4679	381.1385	419.6426	460.0719	502.5227	547.0961	593.8981	643.0401
CUMLLAC	1185.400	1328.109	1477.953	1635.290	1800.493	1973.957	2156.094	2347.338	2548.143	2758.990

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037
LoadLoss (LL-kw)	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.635
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	51.60	54.18	56.89	59.73	62.72	65.86	69.15	72.61	76.24	80.05
LoadLossAnnualCost (LLAC)	221.39	232.46	244.08	256.28	269.10	282.55	296.68	311.52	327.09	343.45
TotalAnnualCost (TAC)	272.9877	286.6371	300.9689	316.0174	331.8182	348.4091	365.8296	384.1211	403.3271	423.4935
CUMTAC	3675.018	3961.655	4262.624	4578.641	4910.459	5258.869	5624.698	6008.819	6412.147	6835.640
CUMNLAC	694.6394	748.8186	805.7067	865.4392	928.1584	994.0135	1063.161	1135.766	1212.002	1292.049
CUMLLAC	2980.378	3212.836	3456.917	3713.202	3982.301	4264.855	4561.537	4873.053	5200.144	5543.590

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$9,826	= $2,990	$1,292	$5,544
PV	PV	PV	PV
$4,538	$2,990	$293	$1,255

CASE: AMORPHOUS CORE - 150 KVA PURCHASE PRICE: $8,060

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	0.099	0.099	0.099	0.099	0.099	0.099	0.099	0.099	0.099	0.099
LoadLoss (LL-kw)	1.122	1.122	1.122	1.122	1.122	1.122	1.122	1.122	1.122	1.122
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	52.03	54.64	57.37	60.24	63.25	66.41	69.73	73.22	76.88	80.72
LoadLossAnnualCost (LLAC)	147.43	154.80	162.54	170.67	179.20	188.16	197.57	207.45	217.82	228.71
TotalAnnualCost (TAC)	199.47	209.44	219.91	230.91	242.45	254.57	267.30	280.67	294.70	309.44
CUMTAC	199.47	408.90	628.81	859.72	1102.17	1356.74	1624.05	1904.71	2199.42	2508.85
CUMNLAC	52.03	106.67	164.04	224.27	287.52	353.93	423.66	496.88	573.76	654.48
CUMLLAC	147.43	302.23	464.78	635.45	814.65	1002.81	1200.38	1407.83	1625.65	1854.37

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	0.099	0.099	0.099	0.099	0.099	0.099	0.099	0.099	0.099	0.099
LoadLoss (LL-kw)	1.122	1.122	1.122	1.122	1.122	1.122	1.122	1.122	1.122	1.122
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	84.76	89.00	93.45	98.12	103.02	108.18	113.58	119.26	125.23	131.49
LoadLossAnnualCost (LLAC)	240.15	252.16	264.76	278.00	291.90	306.50	321.82	337.91	354.81	372.55
TotalAnnualCost (TAC)	324.91	341.15	358.21	376.12	394.93	414.67	435.41	457.18	480.04	504.04
CUMTAC	2833.759	3174.912	3533.123	3909.245	4304.172	4718.846	5154.253	5611.431	6091.469	6595.513
CUMNLAC	739.2416	828.2381	921.6844	1019.803	1122.827	1231.003	1344.587	1463.851	1589.079	1720.567
CUMLLAC	2094.517	2346.674	2611.439	2889.441	3181.344	3487.842	3809.665	4147.579	4502.389	4874.946

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.099	0.099	0.099	0.099	0.099	0.099	0.099	0.099	0.099	0.099
LoadLoss (LL-kw)	1.122	1.122	1.122	1.122	1.122	1.122	1.122	1.122	1.122	1.122
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	138.06	144.97	152.21	159.82	167.82	176.21	185.02	194.27	203.98	214.18
LoadLossAnnualCost (LLAC)	391.18	410.74	431.27	452.84	475.48	499.25	524.22	550.43	577.95	606.85
TotalAnnualCost (TAC)	529.2405	555.7025	583.4877	612.6621	643.2952	675.4599	709.2329	744.6946	781.9293	821.0258
CUMTAC	7124.747	7680.450	8263.938	8876.600	9519.895	10195.35	10904.58	11649.28	12431.21	13252.23
CUMNLAC	1858.629	2003.595	2155.809	2315.634	2483.450	2659.657	2844.675	3038.943	3242.924	3457.105
CUMLLAC	5266.117	5676.854	6108.128	6560.965	7036.444	7535.697	8059.913	8610.339	9188.287	9795.132

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$21,312	=	$8,060	$3,457	$9,795
PV		PV	PV	PV
$11,061		$8,060	$783	$2,218

CASE: AMORPHOUS CORE - 300 KVA PURCHASE PRICE: $13,650

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165
LoadLoss (LL-kw)	1.857	1.857	1.857	1.857	1.857	1.857	1.857	1.857	1.857	1.857
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	86.72	91.06	95.61	100.39	105.41	110.68	116.22	122.03	128.13	134.54
LoadLossAnnualCost (LLAC)	244.01	256.21	269.02	282.47	296.60	311.43	327.00	343.35	360.51	378.54
TotalAnnualCost (TAC)	330.73	347.27	364.63	382.87	402.01	422.11	443.21	465.38	488.64	513.08
CUMTAC	330.73	678.00	1042.64	1425.50	1827.51	2249.62	2692.84	3158.21	3646.85	4159.93
CUMNLAC	86.72	177.78	273.40	373.79	479.20	589.89	706.11	828.14	956.27	1090.81
CUMLLAC	244.01	500.22	769.24	1051.71	1348.31	1659.73	1986.73	2330.08	2690.59	3068.13

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165
LoadLoss (LL-kw)	1.857	1.857	1.857	1.857	1.857	1.857	1.857	1.857	1.857	1.857
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	141.26	148.33	155.74	163.53	171.71	180.29	189.31	198.77	208.71	219.15
LoadLossAnnualCost (LLAC)	397.47	417.34	438.21	460.12	483.12	507.28	532.64	559.27	587.24	616.60
TotalAnnualCost (TAC)	538.73	565.67	593.95	623.65	654.83	687.57	721.95	758.05	795.95	835.75
CUMTAC	4698.664	5264.331	5858.282	6481.930	7136.760	7824.332	8546.282	9304.330	10100.28	10936.02
CUMNLAC	1232.069	1380.396	1536.140	1699.671	1871.379	2051.672	2240.979	2439.752	2648.464	2868.611
CUMLLAC	3466.595	3883.934	4322.141	4782.258	5265.380	5772.659	6305.302	6864.577	7451.816	8068.416

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165
LoadLoss (LL-kw)	1.857	1.857	1.857	1.857	1.857	1.857	1.857	1.857	1.857	1.857
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	230.10	241.61	253.69	266.37	279.69	293.68	308.36	323.78	339.97	356.97
LoadLossAnnualCost (LLAC)	647.43	679.80	713.79	749.48	786.96	826.30	867.62	911.00	956.55	1004.38
TotalAnnualCost (TAC)	877.5352	921.4119	967.4825	1015.856	1066.649	1119.982	1175.981	1234.780	1296.519	1361.345
CUMTAC	11813.56	12734.97	13702.45	14718.31	15784.96	16904.94	18080.92	19315.70	20612.22	21973.57
CUMNLAC	3097.716	3339.326	3593.016	3859.391	4139.084	4432.763	4741.125	5064.905	5404.874	5761.842
CUMLLAC	8715.847	9395.649	10109.44	10858.92	11645.87	12472.18	13339.80	14250.80	15207.35	16211.72

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$35,624	$13,650	$5,762	$16,212
PV	PV	PV	PV
$18,626	$13,650	$1,305	$3,671

CASE: AMORPHOUS CORE - 500 KVA PURCHASE PRICE: $16,380

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
LoadLoss (LL-kw)	3.192	3.192	3.192	3.192	3.192	3.192	3.192	3.192	3.192	3.192
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	120.89	126.93	133.28	139.94	146.94	154.29	162.00	170.10	178.61	187.54
LoadLossAnnualCost (LLAC)	419.43	440.40	462.42	485.54	509.82	535.31	562.07	590.18	619.69	650.67
TotalAnnualCost (TAC)	540.32	567.33	595.70	625.48	656.76	689.60	724.08	760.28	798.29	838.21
CUMTAC	540.32	1107.65	1703.35	2328.83	2985.59	3675.19	4399.26	5159.54	5957.84	6796.05
CUMNLAC	120.89	247.82	381.10	521.04	667.98	822.27	984.27	1154.37	1332.98	1520.52
CUMLLAC	419.43	859.83	1322.25	1807.79	2317.61	2852.92	3414.99	4005.17	4624.86	5275.53

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
LoadLoss (LL-kw)	3.192	3.192	3.192	3.192	3.192	3.192	3.192	3.192	3.192	3.192
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	196.91	206.76	217.10	227.95	239.35	251.32	263.88	277.08	290.93	305.48
LoadLossAnnualCost (LLAC)	683.21	717.37	753.23	790.90	830.44	871.96	915.56	961.34	1009.41	1059.88
TotalAnnualCost (TAC)	880.12	924.13	970.33	1018.85	1069.79	1123.28	1179.44	1238.42	1300.34	1365.35
CUMTAC	7676.165	8600.290	9570.622	10589.47	11659.26	12782.54	13961.98	15200.40	16500.73	17866.09
CUMNLAC	1717.430	1924.189	2141.287	2369.239	2608.589	2859.906	3123.790	3400.867	3691.799	3997.277
CUMLLAC	5958.735	6676.101	7429.335	8220.230	9050.671	9922.633	10838.19	11799.53	12808.93	13868.81

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
LoadLoss (LL-kw)	3.192	3.192	3.192	3.192	3.192	3.192	3.192	3.192	3.192	3.192
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	320.75	336.79	353.63	371.31	389.88	409.37	429.84	451.33	473.90	497.59
LoadLossAnnualCost (LLAC)	1112.87	1168.51	1226.94	1288.29	1352.70	1420.33	1491.35	1565.92	1644.22	1726.43
TotalAnnualCost (TAC)	1433.621	1505.302	1580.567	1659.595	1742.575	1829.704	1921.189	2017.249	2118.111	2224.017
CUMTAC	19299.71	20805.01	22385.58	24045.17	25787.75	27617.45	29538.64	31555.89	33674.00	35898.02
CUMNLAC	4318.028	4654.818	5008.447	5379.757	5769.633	6179.003	6608.841	7060.171	7534.067	8031.659
CUMLLAC	14981.68	16150.19	17377.13	18665.41	20018.11	21438.45	22929.80	24495.72	26139.94	27866.36

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$52,278	=	$16,380	$8,032	$27,866
PV		PV	PV	PV
$24,510		$16,380	$1,819	$6,311

CASE: AMORPHOUS CORE - 750 KVA PURCHASE PRICE: $18,980

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314
LoadLoss (LL-kw)	4.399	4.399	4.399	4.399	4.399	4.399	4.399	4.399	4.399	4.399
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	165.04	173.29	181.95	191.05	200.61	210.64	221.17	232.23	243.84	256.03
LoadLossAnnualCost (LLAC)	578.03	606.93	637.28	669.14	702.60	737.73	774.61	813.34	854.01	896.71
TotalAnnualCost (TAC)	743.07	780.22	819.23	860.19	903.20	948.36	995.78	1045.57	1097.85	1152.74
CUMTAC	743.07	1523.29	2342.52	3202.71	4105.91	5054.28	6050.06	7095.63	8193.48	9346.22
CUMNLAC	165.04	338.33	520.28	711.34	911.94	1122.58	1343.74	1575.97	1819.81	2075.84
CUMLLAC	578.03	1184.96	1822.24	2491.38	3193.97	3931.70	4706.31	5519.66	6373.67	7270.38

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314
LoadLoss (LL-kw)	4.399	4.399	4.399	4.399	4.399	4.399	4.399	4.399	4.399	4.399
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	268.83	282.27	296.39	311.20	326.76	343.10	360.26	378.27	397.18	417.04
LoadLossAnnualCost (LLAC)	941.55	988.63	1038.06	1089.96	1144.46	1201.68	1261.76	1324.85	1391.09	1460.65
TotalAnnualCost (TAC)	1210.38	1270.90	1334.44	1401.16	1471.22	1544.78	1622.02	1703.12	1788.28	1877.69
CUMTAC	10556.59	11827.49	13161.93	14563.09	16034.31	17579.10	19201.12	20904.24	22692.52	24570.21
CUMNLAC	2344.665	2626.937	2923.322	3234.526	3561.291	3904.394	4264.652	4642.925	5040.108	5457.152
CUMLLAC	8211.929	9200.554	10238.61	11328.56	12473.02	13674.70	14936.47	16261.32	17652.41	19113.06

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314
LoadLoss (LL-kw)	4.399	4.399	4.399	4.399	4.399	4.399	4.399	4.399	4.399	4.399
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	437.90	459.79	482.78	506.92	532.27	558.88	586.82	616.16	646.97	679.32
LoadLossAnnualCost (LLAC)	1533.68	1610.37	1690.88	1775.43	1864.20	1957.41	2055.28	2158.04	2265.95	2379.24
TotalAnnualCost (TAC)	1971.577	2070.156	2173.664	2282.347	2396.465	2516.288	2642.103	2774.208	2912.918	3058.564
CUMTAC	26541.79	28611.95	30785.61	33067.96	35464.43	37980.72	40622.82	43397.03	46309.95	49368.51
CUMNLAC	5895.048	6354.838	6837.619	7344.538	7876.804	8435.682	9022.505	9638.668	10285.64	10964.96
CUMLLAC	20646.74	22257.11	23947.99	25723.42	27587.62	29545.03	31600.31	33758.36	36024.30	38403.55

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$68,349	$18,980	$10,965	$38,404
PV	PV	PV	PV
$30,160	$18,980	$2,483	$8,697

CASE: AMORPHOUS CORE - 1000 KVA PURCHASE PRICE: $23,270

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
LoadLoss (LL-kw)	5.484	5.484	5.484	5.484	5.484	5.484	5.484	5.484	5.484	5.484
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	210.24	220.75	231.79	243.38	255.55	268.33	281.74	295.83	310.62	326.15
LoadLossAnnualCost (LLAC)	720.60	756.63	794.46	834.18	875.89	919.69	965.67	1013.95	1064.65	1117.88
TotalAnnualCost (TAC)	930.84	977.38	1026.25	1077.56	1131.44	1188.01	1247.41	1309.78	1375.27	1444.03
CUMTAC	930.84	1908.22	2934.47	4012.03	5143.47	6331.48	7578.89	8888.67	10263.94	11707.98
CUMNLAC	210.24	430.99	662.78	906.16	1161.71	1430.03	1711.78	2007.60	2318.22	2644.38
CUMLLAC	720.60	1477.23	2271.68	3105.87	3981.76	4901.44	5867.11	6881.06	7945.72	9063.61

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
LoadLoss (LL-kw)	5.484	5.484	5.484	5.484	5.484	5.484	5.484	5.484	5.484	5.484
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	342.46	359.58	377.56	396.44	416.26	437.07	458.93	481.87	505.97	531.27
LoadLossAnnualCost (LLAC)	1173.78	1232.47	1294.09	1358.79	1426.73	1498.07	1572.97	1651.62	1734.20	1820.91
TotalAnnualCost (TAC)	1516.24	1592.05	1671.65	1755.23	1842.99	1935.14	2031.90	2133.50	2240.17	2352.18
CUMTAC	13224.21	14816.25	16487.91	18243.14	20086.13	22021.28	24053.18	26186.68	28426.85	30779.03
CUMNLAC	2986.834	3346.416	3723.977	4120.416	4536.677	4973.751	5432.678	5914.552	6420.520	6951.786
CUMLLAC	10237.37	11469.84	12763.93	14122.72	15549.46	17047.53	18620.50	20272.12	22006.33	23827.24

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
LoadLoss (LL-kw)	5.484	5.484	5.484	5.484	5.484	5.484	5.484	5.484	5.484	5.484
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	557.83	585.72	615.01	645.76	678.05	711.95	747.54	784.92	824.17	865.38
LoadLossAnnualCost (LLAC)	1911.96	2007.56	2107.94	2213.33	2324.00	2440.20	2562.21	2690.32	2824.84	2966.08
TotalAnnualCost (TAC)	2469.789	2593.278	2722.942	2859.089	3002.044	3152.146	3309.753	3475.241	3649.003	3831.453
CUMTAC	33248.82	35842.10	38565.04	41424.13	44426.17	47578.32	50888.07	54363.31	58012.32	61843.77
CUMNLAC	7509.615	8095.336	8710.343	9356.100	10034.14	10746.09	11493.63	12278.55	13102.72	13968.10
CUMLLAC	25739.20	27746.76	29854.70	32068.03	34392.03	36832.23	39394.44	42084.76	44909.59	47875.67

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$85,114	= $23,270	$13,968	$47,876
PV	PV	PV	PV
$37,276	$23,270	$3,163	$10,842

CASE: AMORPHOUS CORE - 1500 KVA PURCHASE PRICE: $27,950

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	0.568	0.568	0.568	0.568	0.568	0.568	0.568	0.568	0.568	0.568
LoadLoss (LL-kw)	7.213	7.213	7.213	7.213	7.213	7.213	7.213	7.213	7.213	7.213
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	298.54	313.47	329.14	345.60	362.88	381.02	400.07	420.08	441.08	463.13
LoadLossAnnualCost (LLAC)	947.79	995.18	1044.94	1097.18	1152.04	1209.64	1270.13	1333.63	1400.31	1470.33
TotalAnnualCost (TAC)	1246.33	1308.65	1374.08	1442.78	1514.92	1590.67	1670.20	1753.71	1841.40	1933.47
CUMTAC	1246.33	2554.97	3929.05	5371.83	6886.75	8477.42	10147.62	11901.33	13742.73	15676.19
CUMNLAC	298.54	612.01	941.15	1286.75	1649.63	2030.65	2430.72	2850.80	3291.88	3755.01
CUMLLAC	947.79	1942.97	2987.90	4085.09	5237.13	6446.77	7716.90	9050.53	10450.85	11921.18

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	0.568	0.568	0.568	0.568	0.568	0.568	0.568	0.568	0.568	0.568
LoadLoss (LL-kw)	7.213	7.213	7.213	7.213	7.213	7.213	7.213	7.213	7.213	7.213
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	486.29	510.61	536.14	562.94	591.09	620.64	651.68	684.26	718.47	754.40
LoadLossAnnualCost (LLAC)	1543.85	1621.04	1702.09	1787.20	1876.56	1970.38	2068.90	2172.35	2280.97	2395.01
TotalAnnualCost (TAC)	2030.14	2131.65	2238.23	2350.14	2467.65	2591.03	2720.58	2856.61	2999.44	3149.41
CUMTAC	17706.33	19837.97	22076.20	24426.34	26893.98	29485.01	32205.59	35062.20	38061.64	41211.05
CUMNLAC	4241.305	4751.911	5288.048	5850.991	6442.081	7062.726	7714.403	8398.664	9117.138	9871.536
CUMLLAC	13465.02	15086.06	16788.15	18575.35	20451.90	22422.29	24491.19	26663.54	28944.50	31339.52

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.568	0.568	0.568	0.568	0.568	0.568	0.568	0.568	0.568	0.568
LoadLoss (LL-kw)	7.213	7.213	7.213	7.213	7.213	7.213	7.213	7.213	7.213	7.213
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	792.12	831.72	873.31	916.98	962.82	1010.97	1061.51	1114.59	1170.32	1228.83
LoadLossAnnualCost (LLAC)	2514.76	2640.50	2772.53	2911.15	3056.71	3209.55	3370.02	3538.53	3715.45	3901.22
TotalAnnualCost (TAC)	3306.881	3472.225	3645.837	3828.129	4019.535	4220.512	4431.537	4653.114	4885.770	5130.059
CUMTAC	44517.93	47990.16	51636.00	55464.13	59483.66	63704.17	68135.71	72788.83	77674.60	82804.66
CUMNLAC	10663.65	11495.37	12368.68	13285.66	14248.48	15259.45	16320.96	17435.55	18605.87	19834.70
CUMLLAC	33854.28	36494.78	39267.31	42178.46	45235.18	48444.72	51814.75	55353.27	59068.73	62969.95

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$110,755	= $27,950	$19,835	$62,970
PV	PV	PV	PV
$46,703	$27,950	$4,492	$14,261

CASE: VAPOR-COOLED - 500 KVA PURCHASE PRICE: $17,000

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
LoadLoss (LL-kw)	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	735.84	772.63	811.26	851.83	894.42	939.14	986.10	1035.40	1087.17	1141.53
LoadLossAnnualCost (LLAC)	709.56	745.04	782.29	821.40	862.47	905.60	950.88	998.42	1048.34	1100.76
TotalAnnualCost (TAC)	1445.40	1517.67	1593.55	1673.23	1756.89	1844.74	1936.97	2033.82	2135.51	2242.29
CUMTAC	1445.40	2963.07	4556.62	6229.85	7986.75	9831.48	11768.46	13802.28	15937.80	18180.09
CUMNLAC	735.84	1508.47	2319.74	3171.56	4065.98	5005.12	5991.22	7026.62	8113.79	9255.32
CUMLLAC	709.56	1454.60	2236.89	3058.29	3920.77	4826.37	5777.24	6775.67	7824.01	8924.77

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
LoadLoss (LL-kw)	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1198.61	1258.54	1321.46	1387.54	1456.91	1529.76	1606.25	1686.56	1770.89	1859.43
LoadLossAnnualCost (LLAC)	1155.80	1213.59	1274.27	1337.98	1404.88	1475.12	1548.88	1626.32	1707.64	1793.02
TotalAnnualCost (TAC)	2354.40	2472.12	2595.73	2725.52	2861.79	3004.88	3155.13	3312.88	3478.53	3652.45
CUMTAC	20534.49	23006.61	25602.34	28327.86	31189.65	34194.53	37349.66	40662.54	44141.07	47793.53
CUMNLAC	10453.92	11712.45	13033.92	14421.45	15878.37	17408.12	19014.37	20700.93	22471.82	24331.25
CUMLLAC	10080.56	11294.15	12568.42	13906.40	15311.28	16786.40	18335.29	19961.61	21669.25	23462.27

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
LoadLoss (LL-kw)	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1952.40	2050.02	2152.52	2260.15	2373.16	2491.82	2616.41	2747.23	2884.59	3028.82
LoadLossAnnualCost (LLAC)	1882.67	1976.81	2075.65	2179.43	2288.40	2402.82	2522.96	2649.11	2781.57	2920.65
TotalAnnualCost (TAC)	3835.08	4026.83	4228.17	4439.58	4661.56	4894.64	5139.37	5396.34	5666.15	5949.46
CUMTAC	51628.60	55655.43	59883.60	64323.18	68984.74	73879.38	79018.75	84415.09	90081.24	96030.71
CUMNLAC	26283.65	28333.67	30486.20	32746.35	35119.50	37611.32	40227.73	42974.95	45859.54	48888.36
CUMLLAC	25344.95	27321.75	29397.40	31576.83	33865.24	36268.06	38791.02	41440.13	44221.70	47142.34

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$113,031	=	$17,000	$48,888	$47,142
PV		PV	PV	PV
$38,748		$17,000	$11,072	$10,676

CASE: VAPOR-COOLED - 750 KVA PURCHASE PRICE: $18,500

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	1.816	1.816	1.816	1.816	1.816	1.816	1.816	1.816	1.816	1.816
LoadLoss (LL-kw)	5.814	5.814	5.814	5.814	5.814	5.814	5.814	5.814	5.814	5.814
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	954.49	1002.21	1052.32	1104.94	1160.19	1218.20	1279.11	1343.06	1410.22	1480.73
LoadLossAnnualCost (LLAC)	763.96	802.16	842.27	884.38	928.60	975.03	1023.78	1074.97	1128.72	1185.15
TotalAnnualCost (TAC)	1718.45	1804.37	1894.59	1989.32	2088.79	2193.23	2302.89	2418.03	2538.93	2665.88
CUMTAC	1718.45	3522.82	5417.41	7406.73	9495.52	11688.74	13991.63	16409.66	18948.59	21614.47
CUMNLAC	954.49	1956.70	3009.03	4113.97	5274.16	6492.36	7771.46	9114.53	10524.74	12005.47
CUMLLAC	763.96	1566.12	2408.38	3292.76	4221.36	5196.39	6220.17	7295.13	8423.85	9609.00

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	1.816	1.816	1.816	1.816	1.816	1.816	1.816	1.816	1.816	1.816
LoadLoss (LL-kw)	5.814	5.814	5.814	5.814	5.814	5.814	5.814	5.814	5.814	5.814
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1554.76	1632.50	1714.13	1799.83	1889.82	1984.32	2083.53	2187.71	2297.09	2411.95
LoadLossAnnualCost (LLAC)	1244.41	1306.63	1371.96	1440.56	1512.59	1588.22	1667.63	1751.01	1838.56	1930.49
TotalAnnualCost (TAC)	2799.17	2939.13	3086.09	3240.39	3402.41	3572.53	3751.16	3938.72	4135.65	4342.44
CUMTAC	24413.64	27352.77	30438.86	33679.25	37081.66	40654.19	44405.35	48344.07	52479.72	56822.16
CUMNLAC	13560.23	15192.73	16906.85	18706.69	20596.51	22580.82	24664.36	26852.06	29149.16	31561.10
CUMLLAC	10853.41	12160.04	13532.00	14972.56	16485.15	18073.36	19740.99	21492.00	23330.56	25261.05

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	1.816	1.816	1.816	1.816	1.816	1.816	1.816	1.816	1.816	1.816
LoadLoss (LL-kw)	5.814	5.814	5.814	5.814	5.814	5.814	5.814	5.814	5.814	5.814
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	2532.55	2659.17	2792.13	2931.74	3078.32	3232.24	3393.85	3563.55	3741.72	3928.81
LoadLossAnnualCost (LLAC)	2027.01	2128.36	2234.78	2346.52	2463.85	2587.04	2716.39	2852.21	2994.82	3144.56
TotalAnnualCost (TAC)	4559.56	4787.54	5026.91	5278.26	5542.17	5819.28	6110.24	6415.76	6736.54	7073.37
CUMTAC	61381.71	66169.25	71196.16	76474.42	82016.59	87835.87	93946.11	100361.8	107098.4	114171.7
CUMNLAC	34093.65	36752.82	39544.95	42476.69	45555.01	48787.26	52181.11	55744.65	59486.38	63415.19
CUMLLAC	27288.06	29416.42	31651.20	33997.72	36461.57	39048.61	41765.00	44617.21	47612.03	50756.59

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$132,672	=	$18,500	$63,415	$50,757
PV		PV	PV	PV
$44,356		$18,500	$14,362	$11,495

CASE: VAPOR-COOLED - 1000 KVA PURCHASE PRICE: $19,200

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861
LoadLoss (LL-kw)	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.52
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	978.14	1027.05	1078.40	1132.32	1188.94	1248.38	1310.80	1376.34	1445.16	1517.42
LoadLossAnnualCost (LLAC)	1119.53	1175.50	1234.28	1295.99	1360.79	1428.83	1500.27	1575.29	1654.05	1736.76
TotalAnnualCost (TAC)	2097.67	2202.55	2312.68	2428.31	2549.73	2677.22	2811.08	2951.63	3099.21	3254.17
CUMTAC	2097.67	4300.22	6612.90	9041.22	11590.95	14268.17	17079.24	20030.88	23130.09	26384.26
CUMNLAC	978.14	2005.19	3083.59	4215.91	5404.85	6653.23	7964.04	9340.38	10785.54	12302.96
CUMLLAC	1119.53	2295.03	3529.31	4825.31	6186.10	7614.93	9115.21	10690.49	12344.55	14081.31

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861
LoadLoss (LL-kw)	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.52
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1593.29	1672.95	1756.60	1844.43	1936.65	2033.49	2135.16	2241.92	2354.01	2471.72
LoadLossAnnualCost (LLAC)	1823.59	1914.77	2010.51	2111.04	2216.59	2327.42	2443.79	2565.98	2694.28	2828.99
TotalAnnualCost (TAC)	3416.88	3587.73	3767.11	3955.47	4153.24	4360.90	4578.95	4807.90	5048.29	5300.71
CUMTAC	29801.14	33388.87	37155.98	41111.45	45264.69	49625.60	54204.55	59012.44	64060.74	69361.44
CUMNLAC	13896.24	15569.20	17325.80	19170.23	21106.89	23140.37	25275.53	27517.45	29871.47	32343.19
CUMLLAC	15904.89	17819.66	19830.18	21941.21	24157.80	26485.22	28929.01	31494.99	34189.26	37018.26

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861	1.861
LoadLoss (LL-kw)	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.52	8.52
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	2595.30	2725.07	2861.32	3004.39	3154.60	3312.33	3477.95	3651.95	3834.44	4026.16
LoadLossAnnualCost (LLAC)	2970.44	3118.96	3274.91	3438.66	3610.59	3791.12	3980.68	4179.71	4388.69	4608.13
TotalAnnualCost (TAC)	5565.74	5844.03	6136.23	6443.04	6765.19	7103.45	7458.63	7831.56	8222.14	8634.29
CUMTAC	74927.18	80771.21	86907.44	93350.49	100115.6	107219.1	114677.7	122509.3	130732.4	139366.7
CUMNLAC	34938.48	37663.55	40524.87	43529.25	46683.86	49996.19	53474.14	57125.99	60960.43	64986.59
CUMLLAC	39988.70	43107.66	46382.57	49821.23	53431.82	57222.94	61203.61	65383.32	69772.02	74380.15

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$158,567	=	$19,200	$64,987	$74,380
PV		PV	PV	PV
$50,762		$19,200	$14,717	$16,845

CASE: VAPOR-COOLED - 1500 KVA PURCHASE PRICE: $22,600

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	2.269	2.269	2.269	2.269	2.269	2.269	2.269	2.269	2.269	2.269
LoadLoss (LL-kw)	11.132	11.132	11.132	11.132	11.132	11.132	11.132	11.132	11.132	11.132
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1192.59	1252.22	1314.83	1380.57	1449.60	1522.08	1598.18	1678.09	1761.99	1850.09
LoadLossAnnualCost (LLAC)	1462.74	1535.88	1612.68	1693.31	1777.98	1866.87	1960.22	2058.23	2161.14	2269.20
TotalAnnualCost (TAC)	2655.33	2788.10	2927.50	3073.88	3227.57	3388.95	3558.40	3736.32	3923.13	4119.29
CUMTAC	2655.33	5443.43	8370.93	11444.81	14672.38	18061.33	21619.73	25356.05	29279.18	33398.47
CUMNLAC	1192.59	2444.80	3759.63	5140.20	6589.79	8111.87	9710.05	11388.14	13150.13	15000.22
CUMLLAC	1462.74	2998.63	4611.30	6304.61	8082.59	9949.46	11909.68	13967.91	16129.05	18398.25

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	2.269	2.269	2.269	2.269	2.269	2.269	2.269	2.269	2.269	2.269
LoadLoss (LL-kw)	11.132	11.132	11.132	11.132	11.132	11.132	11.132	11.132	11.132	11.132
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1942.60	2039.73	2141.71	2248.80	2361.24	2479.30	2603.27	2733.43	2870.10	3013.61
LoadLossAnnualCost (LLAC)	2382.66	2501.79	2626.88	2758.22	2896.13	3040.94	3192.99	3352.64	3520.27	3696.28
TotalAnnualCost (TAC)	4325.25	4541.52	4768.59	5007.02	5257.37	5520.24	5796.26	6086.07	6390.37	6709.89
CUMTAC	37723.72	42265.24	47033.83	52040.85	57298.23	62818.47	68614.73	74700.79	81091.16	87801.05
CUMNLAC	16942.82	18982.54	21124.26	23373.06	25734.30	28213.60	30816.86	33550.29	36420.40	39434.00
CUMLLAC	20780.90	23282.69	25909.57	28667.79	31563.93	34604.87	37797.86	41150.49	44670.76	48367.05

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	2.269	2.269	2.269	2.269	2.269	2.269	2.269	2.269	2.269	2.269
LoadLoss (LL-kw)	11.132	11.132	11.132	11.132	11.132	11.132	11.132	11.132	11.132	11.132
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	3164.29	3322.50	3488.63	3663.06	3846.21	4038.52	4240.45	4452.47	4675.09	4908.85
LoadLossAnnualCost (LLAC)	3881.10	4075.15	4278.91	4492.86	4717.50	4953.37	5201.04	5461.09	5734.15	6020.86
TotalAnnualCost (TAC)	7045.38	7397.65	7767.54	8155.91	8563.71	8991.89	9441.49	9913.56	10409.24	10929.70
CUMTAC	94846.44	102244.0	110011.6	118167.5	126731.2	135723.1	145164.6	155078.2	165487.4	176417.1
CUMNLAC	42598.29	45920.79	49409.42	53072.47	56918.68	60957.20	65197.65	69650.12	74325.21	79234.06
CUMLLAC	52248.14	56323.30	60602.21	65095.06	69812.56	74765.93	79966.98	85428.07	91162.22	97183.07

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$199,017	=	$22,600		$79,234	$97,183
PV		PV		PV	PV
$62,553		$22,600		$17,944	$22,009

CASE: VENTILATED DRY - 500 KVA PURCHASE PRICE: $20,100

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
LoadLoss (LL-kw)	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1839.60	1931.58	2028.16	2129.57	2236.05	2347.85	2465.24	2588.50	2717.93	2853.82
LoadLossAnnualCost (LLAC)	748.98	786.43	825.75	867.04	910.39	955.91	1003.70	1053.89	1106.58	1161.91
TotalAnnualCost (TAC)	2588.58	2718.01	2853.91	2996.60	3146.44	3303.76	3468.94	3642.39	3824.51	4015.74
CUMTAC	2588.58	5306.59	8160.50	11157.10	14303.54	17607.30	21076.24	24718.63	28543.14	32558.88
CUMNLAC	1839.60	3771.18	5799.34	7928.91	10164.95	12512.80	14978.04	17566.54	20284.47	23138.29
CUMLLAC	748.98	1535.41	2361.16	3228.20	4138.59	5094.50	6098.20	7152.09	8258.68	9420.59

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
LoadLoss (LL-kw)	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	2996.51	3146.34	3303.66	3468.84	3642.28	3824.40	4015.62	4216.40	4427.22	4648.58
LoadLossAnnualCost (LLAC)	1220.01	1281.01	1345.06	1412.31	1482.93	1557.08	1634.93	1716.68	1802.51	1892.64
TotalAnnualCost (TAC)	4216.52	4427.35	4648.72	4881.15	5125.21	5381.47	5650.55	5933.07	6229.73	6541.21
CUMTAC	36775.40	41202.75	45851.47	50732.62	55857.83	61239.31	66889.85	72822.92	79052.65	85593.86
CUMNLAC	26134.80	29281.14	32584.80	36053.64	39695.92	43520.32	47535.93	51752.33	56179.55	60828.13
CUMLLAC	10640.59	11921.60	13266.66	14678.98	16161.91	17718.98	19353.91	21070.59	22873.10	24765.73

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
LoadLoss (LL-kw)	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	4881.01	5125.06	5381.31	5650.38	5932.89	6229.54	6541.02	6868.07	7211.47	7572.04
LoadLossAnnualCost (LLAC)	1987.27	2086.63	2190.96	2300.51	2415.54	2536.31	2663.13	2796.28	2936.10	3082.90
TotalAnnualCost (TAC)	6868.27	7211.69	7572.27	7950.88	8348.43	8765.85	9204.14	9664.35	10147.57	10654.95
CUMTAC	92462.14	99673.82	107246.0	115196.9	123545.4	132311.2	141515.4	151179.7	161327.3	171982.2
CUMNLAC	65709.13	70834.19	76215.50	81865.87	87798.77	94028.30	100569.3	107437.3	114648.8	122220.9
CUMLLAC	26753.00	28839.63	31030.59	33331.10	35746.64	38282.95	40946.08	43742.36	46678.46	49761.36

LIFE CYCLE COST	=	PURCHASE PRICE	+	NO LOAD LOSS COST	+	LOAD LOSS COST
$192,082	=	$20,100		$122,221		$49,761
PV		PV		PV		PV
$59,049		$20,100		$27,679		$11,269

CASE: VENTILATED DRY - 750 KVA PURCHASE PRICE: $21,500

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
LoadLoss (LL-kw)	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	51
NoLoadAnnualCost (NLAC)	2417.76	2538.65	2665.58	2798.86	2938.80	3085.74	3240.03	3402.03	3572.13	3751.74
LoadLossAnnualCost (LLAC)	1011.78	1062.37	1115.49	1171.26	1229.82	1291.32	1355.88	1423.68	1494.86	1569.60
TotalAnnualCost (TAC)	3429.54	3601.02	3781.07	3970.12	4168.63	4377.06	4595.91	4825.71	5066.99	5321.34
CUMTAC	3429.54	7030.56	10811.62	14781.75	18950.37	23327.43	27923.34	32749.05	37816.04	43137.38
CUMNLAC	2417.76	4956.41	7621.99	10420.85	13359.65	16445.39	19685.42	23087.45	26659.59	30411.33
CUMLLAC	1011.78	2074.15	3189.64	4360.90	5590.72	6882.04	8237.92	9661.60	11156.46	12726.06

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
LoadLoss (LL-kw)	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	3938.28	4135.19	4341.95	4559.05	4787.00	5026.35	5277.67	5541.55	5818.63	6109.56
LoadLossAnnualCost (LLAC)	1648.08	1730.49	1817.01	1907.86	2003.26	2103.42	2208.59	2319.02	2434.97	2556.72
TotalAnnualCost (TAC)	5586.36	5865.68	6158.96	6466.91	6790.25	7129.77	7486.26	7860.57	8253.60	8666.28
CUMTAC	48722.74	54588.42	60747.38	67214.29	74004.54	81134.31	88620.57	96481.13	104734.7	113401.0
CUMNLAC	34348.60	38483.79	42825.74	47384.78	52171.78	57198.13	62475.80	68017.35	73835.98	79945.54
CUMLLAC	14374.14	16104.63	17921.64	19829.50	21832.75	23936.17	26144.76	28463.78	30898.75	33455.47

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
LoadLoss (LL-kw)	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	6415.04	6735.79	7072.58	7426.21	7797.52	8187.39	8596.76	9026.60	9477.93	9951.83
LoadLossAnnualCost (LLAC)	2684.55	2818.78	2959.72	3107.71	3263.09	3426.25	3597.56	3777.44	3966.31	4164.62
TotalAnnualCost (TAC)	9099.59	9554.57	10032.30	10533.91	11060.61	11613.64	12194.32	12804.04	13444.24	14116.45
CUMTAC	122500.6	132055.1	142087.4	152621.3	163681.9	175295.6	187489.9	200293.9	213738.2	227854.6
CUMNLAC	86360.57	93096.36	100168.9	107595.1	115392.6	123580.0	132176.8	141203.4	150681.3	160633.1
CUMLLAC	36140.02	38958.80	41918.52	45026.23	48289.32	51715.57	55313.12	59090.56	63056.87	67221.49

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$249,355	=	$21,500	$160,633	$67,221
PV		PV	PV	PV
$73,102		$21,500	$36,378	$15,224

CASE: VENTILATED DRY - 1000 KVA PURCHASE PRICE: $24,300

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	6	6	6	6	6	6	6	6	6	6
LoadLoss (LL-kw)	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	3153.60	3311.28	3476.84	3650.69	3833.22	4024.88	4226.13	4437.43	4659.30	4892.27
LoadLossAnnualCost (LLAC)	1077.48	1131.35	1187.92	1247.32	1309.68	1375.17	1443.93	1516.12	1591.93	1671.52
TotalAnnualCost (TAC)	4231.08	4442.63	4664.77	4898.00	5142.90	5400.05	5670.05	5953.55	6251.23	6563.79
CUMTAC	4231.08	8673.71	13338.48	18236.48	23379.39	28779.44	34449.49	40403.04	46654.28	53218.07
CUMNLAC	3153.60	6464.88	9941.72	13592.41	17425.63	21450.51	25676.64	30114.07	34773.37	39665.64
CUMLLAC	1077.48	2208.83	3396.76	4644.07	5953.76	7326.93	8772.85	10288.97	11880.90	13552.43

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	6	6	6	6	6	6	6	6	6	6
LoadLoss (LL-kw)	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	5136.88	5393.73	5663.41	5946.58	6243.91	6556.11	6883.91	7228.11	7589.51	7968.99
LoadLossAnnualCost (LLAC)	1755.10	1842.86	1935.00	2031.75	2133.34	2240.00	2352.00	2469.60	2593.08	2722.74
TotalAnnualCost (TAC)	6891.98	7236.58	7598.41	7978.33	8377.25	8796.11	9235.92	9697.71	10182.60	10691.73
CUMTAC	60110.05	67346.63	74945.04	82923.37	91300.62	100096.7	109332.6	119030.3	129212.9	139904.6
CUMNLAC	44802.52	50196.25	55859.66	61806.24	68050.15	74606.26	81490.17	88718.28	96307.80	104276.7
CUMLLAC	15307.52	17150.38	19085.38	21117.13	23250.47	25490.47	27842.47	30312.06	32905.16	35627.9

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	6	6	6	6	6	6	6	6	6	6
LoadLoss (LL-kw)	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	8367.44	8785.81	9225.10	9686.36	10170.68	10679.21	11213.17	11773.83	12362.52	12980.65
LoadLossAnnualCost (LLAC)	2858.88	3001.82	3151.91	3309.51	3474.98	3648.73	3831.17	4022.72	4223.86	4435.05
TotalAnnualCost (TAC)	11226.31	11787.63	12377.01	12995.86	13645.65	14327.93	15044.33	15796.55	16586.37	17415.69
CUMTAC	151131.0	162918.6	175295.6	188291.5	201937.1	216265.1	231309.4	247105.9	263692.3	281108.0
CUMNLAC	112644.2	121430.0	130655.1	140341.5	150512.1	161191.3	172404.5	184178.3	196540.9	209521.5
CUMLLAC	38486.77	41488.59	44640.50	47950.01	51424.99	55073.72	58904.89	62927.61	67151.47	71586.52

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$305,408	= $24,300	$209,522	$71,587
PV	PV	PV	PV
$87,962	$24,300	$47,450	$16,212

CASE: VENTILATED DRY - 1500 KVA PURCHASE PRICE: $32,300

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	8	8	8	8	8	8	8	8	8	8
LoadLoss (LL-kw)	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	4204.80	4415.04	4635.79	4867.58	5110.96	5366.51	5634.83	5916.58	6212.40	6523.02
LoadLossAnnualCost (LLAC)	1261.44	1324.51	1390.74	1460.27	1533.29	1609.95	1690.45	1774.97	1863.72	1956.91
TotalAnnualCost (TAC)	5466.24	5739.55	6026.53	6327.86	6644.25	6976.46	7325.28	7691.55	8076.13	8479.93
CUMTAC	5466.24	11205.79	17232.32	23560.18	30204.43	37180.89	44506.17	52197.72	60273.85	68753.78
CUMNLAC	4204.80	8619.84	13255.63	18123.21	23234.17	28600.68	34235.52	40152.09	46364.50	52887.53
CUMLLAC	1261.44	2585.95	3976.69	5436.96	6970.25	8580.20	10270.66	12045.63	13909.35	15866.26

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	8	8	8	8	8	8	8	8	8	8
LoadLoss (LL-kw)	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	6849.18	7191.63	7551.22	7928.78	8325.22	8741.48	9178.55	9637.48	10119.35	10625.32
LoadLossAnnualCost (LLAC)	2054.75	2157.49	2265.37	2378.63	2497.56	2622.44	2753.57	2891.24	3035.81	3187.60
TotalAnnualCost (TAC)	8903.93	9349.13	9816.58	10307.41	10822.78	11363.92	11932.12	12529.72	13155.16	13812.92
CUMTAC	77657.70	87006.83	96823.41	107130.8	117953.6	129317.5	141249.6	153778.3	166933.5	180746.4
CUMNLAC	59736.69	66928.33	74479.55	82408.32	90733.54	99475.02	108653.5	118291.0	128410.4	139035.7
CUMLLAC	17921.00	20078.50	22343.86	24722.49	27220.06	29842.50	32596.07	35487.31	38523.12	41710.71

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	8	8	8	8	8	8	8	8	8	8
LoadLoss (LL-kw)	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	11156.59	11714.42	12300.14	12915.14	13560.90	14238.95	14950.89	15698.44	16483.36	17307.53
LoadLossAnnualCost (LLAC)	3346.98	3514.32	3690.04	3874.54	4068.27	4271.68	4485.27	4709.53	4945.01	5192.26
TotalAnnualCost (TAC)	14503.56	15228.74	15990.17	16789.68	17629.17	18510.62	19436.16	20407.96	21428.36	22499.78
CUMTAC	195250.0	210478.7	226468.9	243258.6	260887.7	279398.4	298834.5	319242.5	340670.9	363170.6
CUMNLAC	150192.3	161906.7	174206.8	187122.0	200682.9	214921.8	229872.7	245571.1	262054.5	279362.0
CUMLLAC	45057.69	48572.01	52262.05	56136.60	60204.87	64476.55	68961.82	73671.35	78616.36	83808.61

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$395,471	= $32,300	$279,362	$83,809
PV	PV	PV	PV
$114,547	$32,300	$63,267	$18,980

CASE: SEALED DRY - 750 KVA PURCHASE PRICE: $49,600

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	3	3	3	3	3	3	3	3	3	3
LoadLoss (LL-kw)	9	9	9	9	9	9	9	9	9	9
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1576.80	1655.64	1738.42	1825.34	1916.61	2012.44	2113.06	2218.72	2329.65	2446.13
LoadLossAnnualCost (LLAC)	1182.60	1241.73	1303.82	1369.01	1437.46	1509.33	1584.80	1664.04	1747.24	1834.61
TotalAnnualCost (TAC)	2759.40	2897.37	3042.24	3194.35	3354.07	3521.77	3697.86	3882.75	4076.89	4280.74
CUMTAC	2759.40	5656.77	8699.01	11893.36	15247.43	18769.20	22467.06	26349.81	30426.70	34707.44
CUMNLAC	1576.80	3232.44	4970.86	6796.21	8712.82	10725.26	12838.32	15057.03	17386.69	19832.82
CUMLLAC	1182.60	2424.33	3728.15	5097.15	6534.61	8043.94	9628.74	11292.78	13040.01	14874.62

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	3	3	3	3	3	3	3	3	3	3
LoadLoss (LL-kw)	9	9	9	9	9	9	9	9	9	9
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	2568.44	2696.86	2831.71	2973.29	3121.96	3278.05	3441.96	3614.05	3794.76	3984.50
LoadLossAnnualCost (LLAC)	1926.33	2022.65	2123.78	2229.97	2341.47	2458.54	2581.47	2710.54	2846.07	2988.37
TotalAnnualCost (TAC)	4494.77	4719.51	4955.49	5203.26	5463.42	5736.59	6023.42	6324.60	6640.83	6972.87
CUMTAC	39202.20	43921.71	48877.20	54080.46	59543.88	65280.48	71303.90	77628.50	84269.32	91242.19
CUMNLAC	22401.26	25098.12	27929.83	30903.12	34025.07	37303.13	40745.08	44359.14	48153.90	52138.39
CUMLLAC	16800.94	18823.59	20947.37	23177.34	25518.80	27977.34	30558.81	33269.35	36115.42	39103.79

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	3	3	3	3	3	3	3	3	3	3
LoadLoss (LL-kw)	9	9	9	9	9	9	9	9	9	9
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	4183.72	4392.91	4612.55	4843.18	5085.34	5339.60	5606.58	5886.91	6181.26	6490.32
LoadLossAnnualCost (LLAC)	3137.79	3294.68	3459.41	3632.38	3814.00	4004.70	4204.94	4415.19	4635.94	4867.74
TotalAnnualCost (TAC)	7321.51	7687.59	8071.96	8475.56	8899.34	9344.31	9811.52	10302.10	10817.20	11358.06
CUMTAC	98563.70	106251.2	114323.2	122798.8	131698.1	141042.4	150853.9	161156.0	171973.2	183331.2
CUMNLAC	56322.11	60715.02	65327.57	70170.75	75256.08	80595.69	86202.27	92089.19	98270.45	104760.7
CUMLLAC	42241.58	45536.26	48995.67	52628.06	56442.06	60446.77	64651.70	69066.89	73702.83	78570.58

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$232,931	= $49,600	$104,761	$78,571
PV	PV	PV	PV
$91,119	$49,600	$23,725	$17,794

CASE: SEALED DRY - 1000 KVA PURCHASE PRICE: $55,600

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
LoadLoss (LL-kw)	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	2049.84	2152.33	2259.95	2372.95	2491.59	2616.17	2746.98	2884.33	3028.55	3179.97
LoadLossAnnualCost (LLAC)	1563.66	1641.84	1723.94	1810.13	1900.64	1995.67	2095.45	2200.23	2310.24	2425.75
TotalAnnualCost (TAC)	3613.50	3794.18	3983.88	4183.08	4392.23	4611.84	4842.44	5084.56	5338.79	5605.72
CUMTAC	3613.50	7407.68	11391.56	15574.64	19966.87	24578.71	29421.15	34505.71	39844.49	45450.21
CUMNLAC	2049.84	4202.17	6462.12	8835.07	11326.66	13942.83	16689.81	19574.15	22602.69	25782.67
CUMLLAC	1563.66	3205.50	4929.44	6739.57	8640.21	10635.88	12731.33	14931.56	17241.81	19667.55

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
LoadLoss (LL-kw)	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	3338.97	3505.92	3681.22	3865.28	4058.54	4261.47	4474.54	4698.27	4933.18	5179.84
LoadLossAnnualCost (LLAC)	2547.04	2674.39	2808.11	2948.51	3095.94	3250.74	3413.27	3583.94	3763.13	3951.29
TotalAnnualCost (TAC)	5886.01	6180.31	6489.33	6813.79	7154.48	7512.21	7887.82	8282.21	8696.32	9131.13
CUMTAC	51336.22	57516.53	64005.86	70819.65	77974.13	85486.34	93374.16	101656.3	110352.6	119483.8
CUMNLAC	29121.64	32627.56	36308.78	40174.05	44232.60	48494.07	52968.61	57666.88	62600.07	67779.91
CUMLLAC	22214.58	24888.97	27697.08	30645.59	33741.53	36992.27	40405.54	43989.48	47752.61	51703.9

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
LoadLoss (LL-kw)	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	5438.84	5710.78	5996.32	6296.13	6610.94	6941.49	7288.56	7652.99	8035.64	8437.42
LoadLossAnnualCost (LLAC)	4148.86	4356.30	4574.11	4802.82	5042.96	5295.11	5559.86	5837.86	6129.75	6436.24
TotalAnnualCost (TAC)	9587.69	10067.08	10570.43	11098.95	11653.90	12236.59	12848.42	13490.84	14165.39	14873.66
CUMTAC	129071.5	139138.5	149709.0	160807.9	172461.8	184698.4	197546.8	211037.7	225203.1	240076.7
CUMNLAC	73218.75	78929.52	84925.84	91221.97	97832.91	104774.4	112062.9	119715.9	127751.5	136189.0
CUMLLAC	55852.76	60209.06	64783.17	69585.99	74628.95	79924.06	85483.92	91321.78	97451.53	103887.7

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$295,677	=	$55,600	$136,189	$103,888
PV		PV	PV	PV
$109,970		$55,600	$30,843	$23,527

CASE: SEALED DRY - 1500 KVA PURCHASE PRICE: $67,100

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	5	5	5	5	5	5	5	5	5	5
LoadLoss (LL-kw)	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	2628.00	2759.40	2897.37	3042.24	3194.35	3354.07	3521.77	3697.86	3882.75	4076.89
LoadLossAnnualCost (LLAC)	1511.10	1586.66	1665.99	1749.29	1836.75	1928.59	2025.02	2126.27	2232.58	2344.21
TotalAnnualCost (TAC)	4139.10	4346.06	4563.36	4791.53	5031.10	5282.66	5546.79	5824.13	6115.34	6421.11
CUMTAC	4139.10	8485.16	13048.51	17840.04	22871.14	28153.80	33700.59	39524.72	45640.05	52061.15
CUMNLAC	2628.00	5387.40	8284.77	11327.01	14521.36	17875.43	21397.20	25095.06	28977.81	33054.70
CUMLLAC	1511.10	3097.76	4763.74	6513.03	8349.78	10278.37	12303.39	14429.66	16662.24	19006.45

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	5	5	5	5	5	5	5	5	5	5
LoadLoss (LL-kw)	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	4280.74	4494.77	4719.51	4955.49	5203.26	5463.42	5736.59	6023.42	6324.60	6640.83
LoadLossAnnualCost (LLAC)	2461.42	2584.49	2713.72	2849.40	2991.87	3141.47	3298.54	3463.47	3636.64	3818.47
TotalAnnualCost (TAC)	6742.16	7079.27	7433.23	7804.89	8195.13	8604.89	9035.14	9486.89	9961.24	10459.3
CUMTAC	58803.31	65882.57	73315.80	81120.69	89315.83	97920.72	106955.8	116442.7	126403.9	136863.2
CUMNLAC	37335.43	41830.20	46549.71	51505.20	56708.46	62171.88	67908.48	73931.90	80256.50	86897.33
CUMLLAC	21467.87	24052.36	26766.08	29615.49	32607.36	35748.83	39047.37	42510.84	46147.48	49965.96

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	5	5	5	5	5	5	5	5	5	5
LoadLoss (LL-kw)	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	6972.87	7321.51	7687.59	8071.96	8475.56	8899.34	9344.31	9811.52	10302.10	10817.20
LoadLossAnnualCost (LLAC)	4009.40	4209.87	4420.36	4641.38	4873.45	5117.12	5372.98	5641.63	5923.71	6219.89
TotalAnnualCost (TAC)	10982.26	11531.38	12107.95	12713.34	13349.01	14016.46	14717.29	15453.15	16225.81	17037.10
CUMTAC	147845.5	159376.9	171484.8	184198.2	197547.2	211563.6	226280.9	241734.1	257959.9	274997.0
CUMNLAC	93870.19	101191.7	108879.2	116951.2	125426.8	134326.1	143670.4	153481.9	163784.0	174601.2
CUMLLAC	53975.36	58185.22	62605.59	67246.97	72120.41	77237.53	82610.51	88252.14	94175.84	100395.7

LIFE CYCLE COST	=	PURCHASE PRICE	+	NO LOAD LOSS COST	+	LOAD LOSS COST
$342,097	=	$67,100		$174,601		$100,396
PV		PV		PV		PV
$129,378		$67,100		$39,542		$22,736

CASE: CAST COIL - 25 KVA PURCHASE PRICE: $11,769

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.088	0.092
NoLoadLoss (NLL-kw)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
LoadLoss (LL-kw)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	183.96	193.16	202.82	212.96	223.60	234.78	246.52	258.85	271.79	285.38
LoadLossAnnualCost (LLAC)	157.68	165.56	173.84	182.53	191.66	201.24	211.31	221.87	232.97	244.61
TotalAnnualCost (TAC)	341.64	358.72	376.66	395.49	415.27	436.03	457.83	480.72	504.76	529.99
CUMTAC	341.64	700.36	1077.02	1472.51	1887.78	2323.81	2781.64	3262.36	3767.12	4297.11
CUMNLAC	183.96	377.12	579.93	792.89	1016.50	1251.28	1497.80	1756.65	2028.45	2313.83
CUMLLAC	157.68	323.24	497.09	679.62	871.28	1072.52	1283.83	1505.70	1738.67	1983.28

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
LoadLoss (LL-kw)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
LoadRating (LF-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	299.65	314.63	330.37	346.88	364.23	382.44	401.56	421.64	442.72	464.86
LoadLossAnnualCost (LLAC)	256.84	269.69	283.17	297.33	312.20	327.81	344.20	361.41	379.48	398.45
TotalAnnualCost (TAC)	556.50	584.32	613.54	644.21	676.42	710.25	745.76	783.05	822.20	863.31
CUMTAC	4853.61	5437.93	6051.46	6695.68	7372.10	8082.35	8828.10	9611.15	10433.35	11296.65
CUMNLAC	2613.48	2928.11	3258.48	3605.36	3969.59	4352.03	4753.59	5175.23	5617.96	6082.81
CUMLLAC	2240.13	2509.81	2792.98	3090.31	3402.51	3730.31	4074.51	4435.91	4815.39	5213.84

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
LoadLoss (LL-kw)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	488.10	512.51	538.13	565.04	593.29	622.95	654.10	686.81	721.15	757.20
LoadLossAnnualCost (LLAC)	418.37	439.29	461.26	484.32	508.53	533.96	560.66	588.69	618.13	649.03
TotalAnnualCost (TAC)	906.47	951.80	999.39	1049.36	1101.82	1156.91	1214.76	1275.50	1339.27	1406.24
CUMTAC	12203.13	13154.92	14154.31	15203.66	16305.49	17462.40	18677.16	19952.66	21291.93	22698.17
CUMNLAC	6570.91	7083.42	7621.55	8186.59	8779.88	9402.83	10056.93	10743.74	11464.89	12222.09
CUMLLAC	5632.21	6071.50	6532.76	7017.08	7525.61	8059.57	8620.23	9208.92	9827.05	10476.08

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$34,467 =	$11,769	$12,222	$10,476
PV	PV	PV	PV
$16,909	$11,769	$2,768	$2,373

CASE: CAST COIL - 75 KVA PURCHASE PRICE: $12,242

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
LoadLoss (LL-kw)	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	236.52	248.35	260.76	273.80	287.49	301.87	316.96	332.81	349.45	366.92
LoadLossAnnualCost (LLAC)	236.52	248.35	260.76	273.80	287.49	301.87	316.96	332.81	349.45	366.92
TotalAnnualCost (TAC)	473.04	496.69	521.53	547.60	574.98	603.73	633.92	665.61	698.90	733.84
CUMTAC	473.04	969.73	1491.26	2038.86	2613.84	3217.58	3851.50	4517.11	5216.01	5949.85
CUMNLAC	236.52	484.87	745.63	1019.43	1306.92	1608.79	1925.75	2258.56	2608.00	2974.92
CUMLLAC	236.52	484.87	745.63	1019.43	1306.92	1608.79	1925.75	2258.56	2608.00	2974.92

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
LoadLoss (LL-kw)	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
LoadRating (LF-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	385.27	404.53	424.76	445.99	468.29	491.71	516.29	542.11	569.21	597.67
LoadLossAnnualCost (LLAC)	385.27	404.53	424.76	445.99	468.29	491.71	516.29	542.11	569.21	597.67
TotalAnnualCost (TAC)	770.53	809.06	849.51	891.99	936.59	983.42	1032.59	1084.22	1138.43	1195.35
CUMTAC	6720.38	7529.44	8378.95	9270.94	10207.52	11190.94	12223.53	13307.74	14446.17	15641.52
CUMNLAC	3360.19	3764.72	4189.47	4635.47	5103.76	5595.47	6111.76	6653.87	7223.09	7820.76
CUMLLAC	3360.19	3764.72	4189.47	4635.47	5103.76	5595.47	6111.76	6653.87	7223.09	7820.76

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
LoadLoss (LL-kw)	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	627.56	658.94	691.88	726.48	762.80	800.94	840.99	883.04	927.19	973.55
LoadLossAnnualCost (LLAC)	627.56	658.94	691.88	726.48	762.80	800.94	840.99	883.04	927.19	973.55
TotalAnnualCost (TAC)	1255.12	1317.87	1383.77	1452.95	1525.60	1601.88	1681.98	1766.07	1854.38	1947.10
CUMTAC	16896.63	18214.51	19598.27	21051.23	22576.83	24178.71	25860.68	27626.76	29481.14	31428.23
CUMNLAC	8448.32	9107.25	9799.14	10525.61	11288.41	12089.35	12930.34	13813.38	14740.57	15714.12
CUMLLAC	8448.32	9107.25	9799.14	10525.61	11288.41	12089.35	12930.34	13813.38	14740.57	15714.12

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$43,670	=	$12,242	$15,714	$15,714
PV		PV	PV	PV
$19,360		$12,242	$3,559	$3,559

CASE: CAST COIL - 150 KVA PURCHASE PRICE: $14,420

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.088	0.092
NoLoadLoss (NLL-kw)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
LoadLoss (LL-kw)	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	420.48	441.50	463.58	486.76	511.10	536.65	563.48	591.66	621.24	652.30
LoadLossAnnualCost (LLAC)	341.64	358.72	376.66	395.49	415.27	436.03	457.83	480.72	504.76	530.00
TotalAnnualCost (TAC)	762.12	800.23	840.24	882.25	926.36	972.68	1021.31	1072.38	1126.00	1182.31
CUMTAC	762.12	1562.35	2402.58	3284.83	4211.19	5183.87	6205.19	7277.57	8403.57	9585.88
CUMNLAC	420.48	861.98	1325.56	1812.32	2323.42	2860.07	3423.55	4015.21	4636.45	5289.75
CUMLLAC	341.64	700.36	1077.02	1472.51	1887.78	2323.81	2781.64	3262.36	3767.12	4297.11

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
LoadLoss (LL-kw)	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
LoadRating (LF-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	684.92	719.16	755.12	792.88	832.52	874.15	917.86	963.75	1011.94	1062.53
LoadLossAnnualCost (LLAC)	556.50	584.32	613.54	644.21	676.42	710.25	745.76	783.05	822.20	863.31
TotalAnnualCost (TAC)	1241.41	1303.48	1368.66	1437.09	1508.95	1584.39	1663.61	1746.79	1834.13	1925.84
CUMTAC	10827.28	12130.76	13499.42	14936.51	16445.45	18029.85	19693.46	21440.25	23274.39	25200.22
CUMNLAC	5973.67	6692.83	7447.96	8240.83	9073.35	9947.50	10865.36	11829.11	12841.04	13903.57
CUMLLAC	4853.61	5437.93	6051.46	6695.68	7372.10	8082.35	8828.10	9611.15	10433.35	11296.65

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
LoadLoss (LL-kw)	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1115.66	1171.44	1230.01	1291.51	1356.09	1423.89	1495.09	1569.84	1648.34	1730.75
LoadLossAnnualCost (LLAC)	906.47	951.80	999.39	1049.36	1101.82	1156.91	1214.76	1275.50	1339.27	1406.24
TotalAnnualCost (TAC)	2022.13	2123.24	2229.40	2340.87	2457.91	2580.81	2709.85	2845.34	2987.61	3136.99
CUMTAC	27222.35	29345.59	31574.99	33915.86	36373.77	38954.58	41664.43	44509.77	47497.38	50634.37
CUMNLAC	15019.23	16190.67	17420.68	18712.20	20068.29	21492.18	22987.27	24557.11	26205.45	27936.20
CUMLLAC	12203.12	13154.92	14154.30	15203.66	16305.48	17462.40	18677.16	19952.65	21291.93	22698.16

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$65,054	=	$14,420	$27,936	$22,698
PV		PV	PV	PV
$25,887		$14,420	$6,327	$5,140

CASE: CAST COIL - 300 KVA PURCHASE PRICE: $20,644

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
LoadLoss (LL-kw)	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	578.16	607.07	637.42	669.29	702.76	737.89	774.79	813.53	854.21	896.92
LoadLossAnnualCost (LLAC)	486.18	510.49	536.01	562.81	590.95	620.50	651.53	684.10	718.31	754.22
TotalAnnualCost (TAC)	1064.34	1117.56	1173.43	1232.11	1293.71	1358.40	1426.32	1497.63	1572.51	1651.14
CUMTAC	1064.34	2181.90	3355.33	4587.44	5881.15	7239.55	8665.87	10163.50	11736.01	13387.15
CUMNLAC	578.16	1185.23	1822.65	2491.94	3194.70	3932.59	4707.38	5520.91	6375.12	7272.03
CUMLLAC	486.18	996.67	1532.68	2095.50	2686.45	3306.95	3958.48	4642.59	5360.91	6115.12

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
LoadLoss (LL-kw)	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
LoadRating (LF-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	941.76	988.85	1038.29	1090.21	1144.72	1201.95	1262.05	1325.15	1391.41	1460.98
LoadLossAnnualCost (LLAC)	791.94	831.53	873.11	916.76	962.60	1010.73	1061.27	1114.33	1170.05	1228.55
TotalAnnualCost (TAC)	1733.70	1820.38	1911.40	2006.97	2107.32	2212.69	2323.32	2439.49	2561.46	2689.53
CUMTAC	15120.85	16941.23	18852.63	20859.60	22966.92	25179.61	27502.93	29942.42	32503.88	35193.41
CUMNLAC	8213.80	9202.65	10240.94	11331.15	12475.86	13677.82	14939.87	16265.02	17656.43	19117.41
CUMLLAC	6907.06	7738.59	8611.70	9528.46	10491.07	11501.80	12563.07	13677.40	14847.45	16076.01

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
LoadLoss (LL-kw)	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1534.03	1610.73	1691.27	1775.83	1864.62	1957.85	2055.75	2158.54	2266.46	2379.78
LoadLossAnnualCost (LLAC)	1289.98	1354.48	1422.20	1493.31	1567.98	1646.38	1728.70	1815.13	1905.89	2001.18
TotalAnnualCost (TAC)	2824.01	2965.21	3113.47	3269.15	3432.60	3604.23	3784.44	3973.67	4172.35	4380.97
CUMTAC	38017.42	40982.63	44096.11	47365.25	50797.86	54402.09	58186.53	62160.20	66332.55	70713.52
CUMNLAC	20651.44	22262.17	23953.44	25729.27	27593.89	29551.75	31607.50	33766.03	36032.49	38412.28
CUMLLAC	17365.98	18720.46	20142.66	21635.98	23203.96	24850.33	26579.03	28394.16	30300.05	32301.23

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$91,358	=	$20,644	$38,412	$32,301
PV		PV	PV	PV
$36,658		$20,644	$8,699	$7,315

CASE: CAST COIL - 500 KVA PURCHASE PRICE: $25,094

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
LoadLoss (LL-kw)	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	893.52	938.20	985.11	1034.36	1086.08	1140.38	1197.40	1257.27	1320.14	1386.14
LoadLossAnnualCost (LLAC)	814.68	855.41	898.18	943.09	990.25	1039.76	1091.75	1146.34	1203.65	1263.84
TotalAnnualCost (TAC)	1708.20	1793.61	1883.29	1977.46	2076.33	2180.14	2289.15	2403.61	2523.79	2649.98
CUMTAC	1708.20	3501.81	5385.10	7362.56	9438.88	11619.03	13908.18	16311.79	18835.58	21485.56
CUMNLAC	893.52	1831.72	2816.82	3851.18	4937.26	6077.65	7275.05	8532.32	9852.46	11238.61
CUMLLAC	814.68	1670.09	2568.28	3511.37	4501.62	5541.38	6633.13	7779.47	8983.12	10246.96

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
LoadLoss (LL-kw)	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
LoadRating (LF-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1455.45	1528.22	1604.63	1684.87	1769.11	1857.56	1950.44	2047.96	2150.36	2257.88
LoadLossAnnualCost (LLAC)	1327.03	1393.38	1462.05	1536.20	1613.01	1693.66	1778.34	1867.26	1960.62	2058.66
TotalAnnualCost (TAC)	2782.48	2921.60	3067.68	3221.07	3382.12	3551.23	3728.79	3915.23	4110.99	4316.54
CUMTAC	24268.03	27189.63	30257.31	33478.38	36860.50	40411.72	44140.51	48055.73	52166.72	56483.26
CUMNLAC	12694.04	14222.27	15826.90	17511.76	19280.87	21138.44	23088.88	25136.84	27287.21	29545.09
CUMLLAC	11573.98	12967.36	14430.41	15966.61	17579.62	19273.28	21051.62	22918.89	24879.51	26938.17

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
LoadLoss (LL-kw)	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	2370.77	2489.31	2613.78	2744.47	2881.69	3025.78	3177.06	3335.92	3502.71	3677.85
LoadLossAnnualCost (LLAC)	2161.59	2269.67	2383.15	2502.31	2627.42	2758.80	2896.74	3041.57	3193.65	3353.33
TotalAnnualCost (TAC)	4532.363	4758.981	4996.930	5246.776	5509.115	5784.571	6073.800	6377.490	6696.364	7031.182
CUMTAC	61015.62	65774.60	70771.53	76018.31	81527.43	87312.00	93385.80	99763.29	106459.6	113490.8
CUMNLAC	31915.86	34405.17	37018.95	39763.42	42645.11	45670.89	48847.95	52183.87	55686.58	59364.43
CUMLLAC	29099.76	31369.42	33752.57	36254.88	38882.31	41641.10	44537.84	47579.41	50773.06	54126.40

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$138,585	=	$25,094	$59,364	$54,126
PV		PV	PV	PV
$50,796		$25,094	$13,444	$12,258

CASE: CAST COIL - 750 KVA PURCHASE PRICE: $32,107

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
LoadLoss (LL-kw)	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1103.76	1158.95	1216.90	1277.74	1341.63	1408.71	1479.14	1553.10	1630.76	1712.29
LoadLossAnnualCost (LLAC)	1024.92	1076.17	1129.97	1186.47	1245.80	1308.09	1373.49	1442.17	1514.27	1589.99
TotalAnnualCost (TAC)	2128.68	2235.11	2346.87	2464.21	2587.42	2716.80	2852.63	2995.27	3145.03	3302.28
CUMTAC	2128.68	4363.79	6710.66	9174.88	11762.30	14479.10	17331.73	20327.00	23472.03	26774.31
CUMNLAC	1103.76	2262.71	3479.60	4757.34	6098.97	7507.68	8986.82	10539.92	12170.68	13882.97
CUMLLAC	1024.92	2101.09	3231.06	4417.53	5663.33	6971.42	8344.91	9787.07	11301.35	12891.33

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
LoadLoss (LL-kw)	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
LoadRating (LF-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1797.91	1887.80	1982.19	2081.30	2185.37	2294.64	2409.37	2529.84	2656.33	2789.15
LoadLossAnnualCost (LLAC)	1669.49	1752.96	1840.61	1932.64	2029.27	2130.74	2237.27	2349.14	2466.59	2589.92
TotalAnnualCost (TAC)	3467.40	3640.77	3822.80	4013.94	4214.64	4425.37	4646.64	4878.97	5122.92	5379.07
CUMTAC	30241.70	33882.46	37705.27	41719.21	45933.85	50359.22	55005.87	59884.84	65007.76	70386.83
CUMNLAC	15680.88	17568.68	19550.88	21632.18	23817.55	26112.19	28521.56	31051.40	33707.73	36496.87
CUMLLAC	14560.82	16313.78	18154.39	20087.02	22116.30	24247.03	26484.30	28833.44	31300.03	33889.95

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
LoadLoss (LL-kw)	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	2928.60	3075.03	3228.79	3390.23	3559.74	3737.72	3924.61	4120.84	4326.88	4543.23
LoadLossAnnualCost (LLAC)	2719.42	2855.39	2998.16	3148.07	3305.47	3470.74	3644.28	3826.49	4017.82	4218.71
TotalAnnualCost (TAC)	5648.02	5930.42	6226.94	6538.29	6865.21	7208.47	7568.89	7947.33	8344.70	8761.94
CUMTAC	76034.85	81965.27	88192.22	94730.51	101595.7	108804.1	116373.0	124320.4	132665.1	141427.0
CUMNLAC	39425.48	42500.51	45729.30	49119.52	52679.26	56416.98	60341.59	64462.43	68789.31	73332.54
CUMLLAC	36609.37	39464.76	42462.92	45610.98	48916.45	52387.20	56031.48	59857.97	63875.79	68094.50

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$173,534	=	$32,107	$73,333	$68,095
PV		PV	PV	PV
$64,136		$32,107	$16,608	$15,421

CASE: CAST COIL - 1000 KVA PURCHASE PRICE: $37,323

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
LoadLoss (LL-kw)	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1471.68	1545.26	1622.53	1703.65	1788.84	1878.28	1972.19	2070.80	2174.34	2283.06
LoadLossAnnualCost (LLAC)	1064.34	1117.56	1173.43	1232.11	1293.71	1358.40	1426.32	1497.63	1572.51	1651.14
TotalAnnualCost (TAC)	2536.02	2662.82	2795.96	2935.76	3082.55	3236.68	3398.51	3568.43	3746.86	3934.20
CUMTAC	2536.02	5198.84	7994.80	10930.56	14013.11	17249.79	20648.30	24216.73	27963.59	31897.79
CUMNLAC	1471.68	3016.94	4639.47	6343.12	8131.96	10010.24	11982.43	14053.23	16227.57	18510.63
CUMLLAC	1064.34	2181.90	3355.33	4587.44	5881.15	7239.55	8665.87	10163.50	11736.01	13387.15

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.152
NoLoadLoss (NLL-kw)	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
LoadLoss (LL-kw)	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
LoadRating (LF-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	2397.21	2517.07	2642.93	2775.07	2913.83	3059.52	3212.49	3373.12	3541.77	3718.86
LoadLossAnnualCost (LLAC)	1733.70	1820.38	1911.40	2006.97	2107.32	2212.69	2323.32	2439.49	2561.46	2689.53
TotalAnnualCost (TAC)	4130.91	4337.45	4554.33	4782.04	5021.15	5272.20	5535.81	5812.60	6103.23	6408.40
CUMTAC	36028.69	40366.15	44920.47	49702.52	54723.66	59995.87	65531.68	71344.29	77447.52	83855.92
CUMNLAC	20907.84	23424.91	26067.84	28842.91	31756.74	34816.25	38028.75	41401.86	44943.64	48662.50
CUMLLAC	15120.85	16941.23	18852.63	20859.60	22966.92	25179.61	27502.93	29942.42	32503.88	35193.41

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
LoadLoss (LL-kw)	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	3904.81	4100.05	4305.05	4520.30	4746.32	4983.63	5232.81	5494.45	5769.18	6057.63
LoadLossAnnualCost (LLAC)	2824.01	2965.21	3113.47	3269.15	3432.60	3604.23	3784.44	3973.67	4172.35	4380.97
TotalAnnualCost (TAC)	6728.82	7065.26	7418.52	7789.45	8178.92	8587.86	9017.26	9468.12	9941.53	10438.60
CUMTAC	90584.73	97649.99	105068.5	112857.9	121036.8	129624.7	138641.9	148110.1	158051.6	168490.2
CUMNLAC	52567.30	56667.35	60972.40	65492.70	70239.01	75222.64	80455.46	85949.91	91719.08	97776.72
CUMLLAC	38017.42	40982.63	44096.11	47365.25	50797.86	54402.09	58186.53	62160.20	66332.55	70713.52

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$205,813	=	$37,323		$97,777		$70,714
PV		PV		PV		PV
$75,481		$37,323		$22,143		$16,014

CASE: CAST COIL - 1500 KVA PURCHASE PRICE: $51,600

ITEM	YEAR 1	2	3	4	5	6	7	8	9	10
Energy Cost ($/kwh)	0.060	0.063	0.066	0.069	0.073	0.077	0.080	0.084	0.089	0.093
NoLoadLoss (NLL-kw)	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
LoadLoss (LL-kw)	11	11	11	11	11	11	11	11	11	11
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	1997.28	2097.14	2202.00	2312.10	2427.71	2549.09	2676.55	2810.37	2950.89	3098.44
LoadLossAnnualCost (LLAC)	1445.40	1517.67	1593.55	1673.23	1756.89	1844.74	1936.97	2033.82	2135.51	2242.29
TotalAnnualCost (TAC)	3442.68	3614.81	3795.55	3985.33	4184.60	4393.83	4613.52	4844.20	5086.41	5340.73
CUMTAC	3442.68	7057.49	10853.05	14838.38	19022.98	23416.81	28030.33	32874.53	37960.93	43301.66
CUMNLAC	1997.28	4094.42	6296.43	8608.53	11036.23	13585.32	16261.87	19072.24	22023.14	25121.57
CUMLLAC	1445.40	2963.07	4556.62	6229.85	7986.75	9831.48	11768.46	13802.28	15937.80	18180.09

ITEM	YEAR 11	12	13	14	15	16	17	18	19	20
Energy Cost ($/kwh)	0.098	0.103	0.108	0.113	0.119	0.125	0.131	0.138	0.144	0.151
NoLoadLoss (NLL-kw)	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
LoadLoss (LL-kw)	11	11	11	11	11	11	11	11	11	11
LoadRating (LF-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	3253.36	3416.03	3586.83	3766.17	3954.48	4152.20	4359.81	4577.80	4806.69	5047.03
LoadLossAnnualCost (LLAC)	2354.40	2472.12	2595.73	2725.52	2861.79	3004.88	3155.13	3312.88	3478.53	3652.45
TotalAnnualCost (TAC)	5607.76	5888.15	6182.56	6491.69	6816.27	7157.08	7514.94	7890.69	8285.22	8699.49
CUMTAC	48909.42	54797.57	60980.13	67471.81	74288.08	81445.17	88960.11	96850.79	105136.0	113835.4
CUMNLAC	28374.93	31790.95	35377.78	39143.95	43098.43	47250.63	51610.44	56188.24	60994.94	66041.96
CUMLLAC	20534.49	23006.61	25602.34	28327.86	31189.65	34194.53	37349.66	40662.54	44141.07	47793.52

ITEM	YEAR 21	22	23	24	25	26	27	28	29	30
Energy Cost ($/kwh)	0.159	0.167	0.176	0.184	0.194	0.203	0.213	0.224	0.235	0.247
NoLoadLoss (NLL-kw)	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
LoadLoss (LL-kw)	11	11	11	11	11	11	11	11	11	11
LoadRating (LR-%)	50	50	50	50	50	50	50	50	50	50
NoLoadAnnualCost (NLAC)	5299.38	5564.35	5842.56	6134.69	6441.43	6763.50	7101.67	7456.76	7829.60	8221.08
LoadLossAnnualCost (LLAC)	3835.08	4026.83	4228.17	4439.58	4661.56	4894.64	5139.37	5396.34	5666.15	5949.46
TotalAnnualCost (TAC)	9134.45	9591.18	10070.74	10574.27	11102.99	11658.14	12241.04	12853.10	13495.75	14170.54
CUMTAC	122969.9	132561.1	142631.8	153206.1	164309.1	175967.2	188208.3	201061.4	214557.1	228727.6
CUMNLAC	71341.34	76905.69	82748.25	88882.95	95324.37	102087.8	109189.5	116646.3	124475.9	132696.9
CUMLLAC	51628.60	55655.43	59883.60	64323.18	68984.74	73879.38	79018.75	84415.09	90081.24	96030.71

LIFE CYCLE COST = PURCHASE PRICE + NO LOAD LOSS COST + LOAD LOSS COST

$280,328	=	$51,600	$132,697	$96,031
PV		PV	PV	PV
$103,400		$51,600	$30,052	$21,748

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MCLB Code 555, Albany, GA

MCAS Code 1JD-31 (Huang), El Toro, CA; Code 3JD, Yuma, AZ; Code 44, Cherry Point, NC; Code LCU, Cherry Point, NC; El Toro, 1JF, Santa Ana, CA; El Toro, Code 1JD, Santa Ana, CA; PWO, Kaneohe Bay, HI; PWO, Yuma, AZ

MCLB Maint Offr, Barstow CA; PWO, Barstow, CA

MCRDAC AROICC, Quantico, VA; Base Maint Offr, Quantico, VA; M & L Div Quantico, VA

NAF Detroit, PWO, Mount Clemens, MI; PWO, Atsugi, Japan; PWO, Misawa, Japan

NAS CO, Norfolk, VA; Chase Fld, Code 18300, Beeville, TX; Chase Fld, PWO, Beeville, TX; Code 072E, Willow Grove, PA; Code 163, Keflavik, Iceland; Code 1833, Corpus Christi, TX; Code 183P, Corpus Christi, TX; Code 187, Jacksonville, FL; Code 18700, Brunswick, ME; Code 6234 (C Arnold), Point Mugu, CA; Code 70, Marietta, GA; Code 70, South Weymouth, MA; Code 725, Marietta, GA; Code 8, Patuxent River, MD; Dir, Engrg Div, Meridian, MS; Dir, Engrg Div, PWD, Keflavik, Iceland; Dir, Maint Control, Adak, AK; Fac Mgmt Offc, Alameda, CA; Memphis, Code 18200, Millington, TN; Memphis, Dir, Engrg Div, Millington, TN; Memphis, PWO, Millington, TN; Miramar, Code 1821A, San Diego, CA; Miramar, PWO Code 183, San Diego, CA; Miramar, PWO, San Diego, CA; NI, Code 183, San Diego, CA; Oceana, PWO, Virginia Bch, VA; PW Engrg (Branson), Patuxent River, MD; PWD (Graham), Lemoore, CA; PWD Maint Div, New Orleans, LA; PWO (Code 182) Bermuda; PWO (Code 6200), Point Mugu, CA; PWO, Adak, AK; PWO, Bermuda; PWO, Cecil Field, FL; PWO, Corpus Christi, TX; PWO, Dallas, TX; PWO, Fallon, NV; PWO, Glenview, IL; PWO, Jacksonville, FL; PWO, Keflavik, Iceland; PWO, Key West, FL; PWO, Kingsville TX; PWO, Meridian, MS; PWO, Moffett Field, CA; PWO, New Orleans, LA; PWO, Sigonella, Italy; PWO, South Weymouth, MA; PWO, Willow Grove, PA; SCE, Alameda, CA; SCE, Norfolk, VA; SCE, Pensacola, FL; Whidbey Is, PWO, Oak Harbor, WA; Whiting Fld, PWO, Milton, FL

NAVAIRDEVCEN Code 832, Warminster, PA; Code 8323, Warminster, PA

NAVAIRENGCEN Code 1822, Lakehurst, NJ; Code 18232 (Collier), Lakehurst, NJ; PWO, Lakehurst, NJ

NAVAIRPROPCEN CO, Trenton, NJ

NAVAIRTESTCEN PWO, Patuxent River, MD

NAVAMPHIB BASE Naval Amphib Base - LC, Norfolk, VA

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NAVAVNDEPOT Code 61000, Cherry Point, NC; Code 640, Pensacola, FL; SCE, Norfolk, VA

NAVCAMS PWO, Norfolk, VA

NAVCHAPGRU Code 50, Williamsburg, VA

NAVCOASTSYSCEN Code 423, Panama City, FL; PWO (Code 740), Panama City, FL

NAVCOMM DET MED, SCE, Sigonella, Italy

NAVCOMMSTA CO, San Miguel, R.P.; PWO, Exmouth, Australia; PWO, Nea Makri, Greece; PWO, Thurso, UK

NAVCONSTRACEN Code 00000, Port Hueneme, CA; Code B-1, Port Hueneme, CA

NAVELEXCEN DET, OIC, Winter Harbor, ME

NAVFAC Centerville Bch, PWO, Ferndale, CA; Code 183, Argentia, NF; N62, Argentia, NF; PWO (Code 50), Brawdy Wales, UK; PWO, Oak Harbor, WA

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NETC Code 46, Newport, RI; PWO, Newport, RI
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PHIBCB 1, P&E, San Diego, CA

PWC ACE (Code 110), Great Lakes, IL; ACE Office, Norfolk, VA; Code 10, Great Lakes, IL; Code 10, Oakland, CA; Code 100E, Great Lakes, IL; Code 101 (Library), Oakland, CA; Code 101, Great Lakes, IL; Code 1011, Pearl Harbor, HI; Code 102, Oakland, CA; Code 110, Oakland, CA; Code 110C, Oakland, CA; Code 120, San Diego, CA; Code 123C, San Diego, CA; Code 30, Norfolk, VA; Code 400, Great Lakes, IL; Code 400, Oakland, CA; Code 400, Pearl Harbor, HI; Code 420, Great Lakes, IL; Code 420, Oakland, CA; Code 420, San Diego, CA; Code 420B (Waid), Subic Bay, RP; Code 421 (Reynolds), San Diego, CA; Code 421, San Diego, CA; Code 422, San Diego, CA; Code 423, San Diego, CA; Code 423/KJF, Norfolk, VA; Code 424, Norfolk, VA; Code 430 (Kyi), Pearl Harbor, HI

PWC Code 430 (Kyi), Pearl Harbor, HI

PWC Code 4450A (T. Ramon), Pensacola, FL; Code 50, Pensacola, FL; Code 500, Great Lakes, IL; Code 500, Norfolk, VA; Code 500, Oakland, CA; Code 505A, Oakland, CA; Code 590, San Diego, CA; Code 600, Great Lakes, IL; Code 610, San Diego, CA; Code 612, Pearl Harbor, HI; Code 615, Guam, Mariana Islands; Code 616, Subic Bay, RP; Code 700, Great Lakes, IL; Library, Norfolk, VA; Library, Pensacola, FL; PWC, C-422, Pearl Harbor, HI

RNCB Lant, CO, Norfolk, VA

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